GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: 10/8/80

Project Title: State Transportation Surveillance Program (Radiological Material)

Project No: E-26-657 (Continuation of B-10-659, which began 10/01/78).

Project Director: Dr. M. W. Carter

Sponsor: Georgia Department of Human Resources (Radiological Health)

Agreement Period: From 07/01/80 Until 09/30/80

Type Agreement: Contract No. 427-93-90634

Amount:

GDHR		GIT		TOTAL
$ 21,286.74	B-10-659	$ 17,679.78	B-10-321	$ 38,966.52
18,813.26	E-26-657	2,540.22	E-26-322	21,353.48
$ 40,100.00		$ 20,220.00		$ 60,320.00

Reports Required: Quarterly Progress Report; Expenditure; Equipment; & In-Kind Match Report
Annual Progress Report; Annual Equipment Inventory

Sponsor Contact Person (s):

Technical Matters

Contractual Matters
(thru OCA)

Mr. Will Ingram
Radiological Health Unit
Ga. Dept. of Human Resources
State Office Building
47 Trinity Avenue
Atlanta, Georgia 30334

894-5795

Defense Priority Rating: Not Applicable

Assigned to: Nuclear Engineering (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
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Project File (OCA)
Project Code (GTRI)
Other

CA—3 (3/76)

SR466 130

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 8/27/81

Project Title: State Transporation Surveillance Program (Radiological Material)

Project No: E-26-657 (Continuation of B-10-659)

Project Director: Dr. Melvin W. Carter

Sponsor: Ga. Department of Human Resources

Effective Termination Date: 12/31/80

Clearance of Accounting Charges: 12/31/80

Grant/Contract Closeout Actions Remaining:

_ Final Invoice and Closing Documents
_ Final Fiscal Report
_ Final Report of Inventions
x Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
x Other Annual Equipment Inventory Report

Assigned to: Nuclear Engineering (School/~~Laboratory~~)

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GEORGIA INSTITUTE OF TECHNOLOGY

ENVIRONMENTAL RESOURCES CENTER
205 OLD CIVIL ENGINEERING BLDG
ATLANTA, GEORGIA 30332

(404) 894-2375

TO: Dr. Wayne Schumann, Director Attn: Mr. Willard Ingram
Radiological-Occupational Health Unit, Georgia DHR

FROM: Dr. Bernd Kahn, Director
Environmental Resources Center

DATE: April 7, 1980

SUBJ: Fifth Quarterly Report of Progress (October 1-December 31, 1979) of Extended State Transportation Surveillance Program - Radioactive Materials - under agreement between Georgia Department of Human Resources and Georgia Institute of Technology

Measurements by TLD of the radiation exposures of persons who work with transported RAM were collected for periods ending October 25 and December 13 to complete thirteen months of measurement at approximately 4-week intervals. These results for 101 workers have been compiled and are being presented in the annual report for October 1978 - September 1979. In brief, the following distribution of exposures, averaged on a weekly basis, was found:

Category	No. of Workers	person-weeks	Avg. gross exposure rate, mR/week	
control	3	95	1.3-1.6	(avg., 1.5)
no detect. RAM exposure	41	1297	1.0-2.0	(avg., 1.5 ±0.3)
slight RAM exposure	31	1001	2.1-7.9	
elevated RAM exposure	10	199	12-109.	
insufficient data	16	---	-------	

The net exposure rate value due to RAM is the above value minus the natural radiation background of 1.5 mR/week. Exposures were considered to be "elevated" if the average weekly gross rate exceeded 11.1 mR, i.e. 500 mR/year due to RAM. Workers were placed in the"insufficient data" category if fewer than 8 weeks of radiation data could be collected for them due to changes in jobs or their lack of cooperation. These measurements provide an overview of the exposure rate of drivers, handlers, and supervisors and indicate that the workers that receive highest exposures are usually drivers for certain routes. These measurements are being continued at reduced frequency, in that TLD's are now being collected at 3-month intervals.

Radiation exposures in vehicles were monitored on a continuing basis, both by placing TLD's behind drivers' seats for 4-week period and with survey instruments when the loaded vehicles arrived or departed at the Purolator terminal. The TLD values are summarized in the annual report. The survey

results given in Table 1 show that in three instances the dose rate exceeded 10 mrem/hr 6 ft from the sides of a vehicles, and in one instance it exceeded 2 mrem/hr at the driver's seat. In a few other instances, dose rates were maintained at low values despite TI values of the order of 100 per load. Observations concerning monitored RAM shipments are presented in the appendix.

Site monitoring with TLD's exposed at terminals where RAM are handled was continued on a quarterly basis with the results shown in Table 2. The radiation background is in the range 14-26 mR/quarter. Elevated values were observed at a number of RAM storage locations, the highest being 450 mR/quarter at the Purolator terminal.

Examination of shipment records to describe the transport of RAM in the state by origin, destination, radioisotope, quantity, and exposure potential was continued, with data summarized in Tables 3 to 6. The information from the Purolator terminal in Tables 3-5 can be compared with that in previous reports (see Report for Third Quarter, Table 7) to indicate the continuing major changes in shipments. These include:

September 19, 1978:	First indication that Skycab delivered RAM to Purolator Terminal for distribution to Georgia, Florida, Alabama, and Tennessee.
February 1979:	Associated Courier started to deliver RAM to Atlanta and Orlando eliminating transport by Purolator (Ryder Truck).
April 1979:	Associated Courier started to deliver RAM to Charlotte, N.C. via Atlanta, to eliminate transport by Purolator to Charlotte.
September 1979:	New England Nuclear began shipping RAM to Atlanta and Tennessee on its own trucks in place of transport by Baltimore Airways; this also eliminated transport by Purolator from Charlie Brown or Atlanta Airports to its terminal.

Table 6 presents radioisotope RAM shipments for a full year from the Nuclear Radiation Center, Georgia Institute of Technology, where these are produced by activation in a research reactor. Waste RAM from the Center and other schools in Atlanta were shipped to Barnwell for burial as indicated in Table 7.

The results of gamma-ray spectral analysis with a Ge(Li) detector of smears obtained during surveys of radiopharmaceutical packages and RAM transport vehicles are shown in Table 8. This table presents results

for all elevated values collected in the indicated period; all other smears contained no detectable radioactivity. The elevated levels are, in all cases, very low compared to regulatory contamination limits. Most notable is the detection of Se-75 on many of the containers.

This third year of study of transporting RAM in Georgia will respond as follows to the conclusions developed from observations in the two previous years of study:

Worker exposure--1. The greatest potential for exposure is to drivers who transport large TI values, which currently means numerous Mo-99 generators. Elevated exposures resulted from proximity of the Mo-99 containers to the drivers and loading and unloading by drivers. These major shipments will continue to be surveyed to document exposures, advise use of exposure reduction procedures, and assure that any new regular shipments in this continuously changing pattern of RAM transportation are maintained at low personnel exposure levels.

2. Handling RAM at terminals usually results in minor radiation exposure because the packages are handled quickly and remain in place only briefly and handlers are rotated through varied assignments. Occasional elevated exposures occur when supervisors become careless with regard to storing RAM at locations near workers or permitting workers to remain near such storage. Efforts will be made to examine techniques that are effective in maintaining good practices for avoiding extended workers exposure to RAM stored at terminals.

3. On the request of U.S. DOT staff, exposure rates from Mo-99 generators will be determined as a function of stacking configuration and distance per specified TI for packages from several suppliers. These measurements will be performed next quarter.

Population exposure--Surface contamination of packages, excessive exposure rates near vehicles and accidents that result in radioactive contamination or radiation exposure have been very infrequent; the resulting population exposure would have been extremely low. The major concern usually is directed toward the potential for exposure due to an accident, in view of relatively frequent RAM shipment on Georgia roads. Information on the frequency and exposure potential will be collected in continuation from past years. The recently promulgated regulations by the Georgia DOT that require registration of transporters and notification of specified RAM shipments may permit a more complete survey of this activity and also provide the opportunity for more representative monitoring of vehicles in transit.

Compliance--Infractions of transport regulations have been relatively minor with respect to potential overexposure. The main source of exposure has been shipment of large TI values per vehicle, but even this practice has recently been reduced. Documentation of items of noncompliance and elevated exposure rates due to shipments of large TI values will be continued.

Recommendations for exposure reduction.--Discussions with workers and supervisors in the course of monitoring RAM handling have led to noticeable reductions of worker radiation exposure as the importance of maximum distance, sufficient shielding and minimum time for exposure were emphasized. A problem in

maintaining good practices, however, is the rapid turnover and reassignment of personnel. Procedures for coping with this problem will be considered, notably requirements for personnel dose measurements at frequent intervals to identify elevated exposure situations promptly, and simple but frequently repeated training programs.

Table 1

Vehicle Monitoring Results

Date	Location	Vehicle #	Route	Radiation Levels (mrem/hr) Cab	Surface	Six ft	Transport Index	Excessive Removable Contamination	Package Placement	Proper Shipping Documents	Placard	Remarks
October, 1979												
18	Ga. Tech	2-160	Atlanta to Barnwell S.C.	0.06	0.8	0.13	LSA	none	Cask secured to trailer	yes	yes	Cask USA 6144/B
25	Note 1	15207	014	0.0	16	unk	16.6	unk	Rear	yes	yes	
		15181	028	0.0	19	unk	15.5	unk	Rear	yes	yes	
		15170	305	0.0	5	unk	2.2	unk	Right rear	yes	yes	
		16152	Atlanta to Birmingham	0.2	15	0.9	3.5	unk	Right rear	yes	no	Note 3
27		P83094	Note 2	0.5	95	15.	252.5	yes	Rear	yes	yes	Inbound Atlanta
		P83094	Note 2	0.5	95	13	198.3	yes	Rear	yes	yes	Outbound Atlanta
		XRC92U	Note 4					unk	Full		yes	Note 5
28		55	Note 6	0.03	12	1.0	104.9	yes	Front	yes	yes	
		15209	015	0.5	18	1.8	27.5	unk	Rear	yes	yes	
		15164	005	0.1	3.6	0.4	2.0	unk	Left Rear	yes	no	Note 7
		16721	400	0.8	10	unk	14.3	unk	Rear	yes	yes	
		15219	080	1.6	unk	unk	22.2	unk	Middle Rear	yes	yes	
		15145	008	0.3	15	1.5	14.2	unk	Rear	yes	yes	
		15214	028	0.3	60	5	94.2	unk	Rear	yes	yes	
		15189	101	1.4	10	1.4	20.2	unk	Rear	yes	yes	
November, 1979												
27	Note 8	544	Note 8	0.11	9.	1.1	LSA	none	Cask	yes	yes	
	Ga. Tech	881	Atlanta to Barnwell, S.C.	0.03	1.3	0.1	LSA	none	Trailer Full	yes	yes	Note 9
December, 1979												
1		XRC92U	Note 4	3.0	70	unk	unk	none	Full	Note 10	Note 10	
		XRC92U	Note 4	0.8	50	3.5	unk	none	Rear	yes	yes	Note 11

	P83094	Note 2 and 12	0.5	100 (0.9 sleeper)	18	196.3	yes	Rear	yes	yes	Note 13
2	15212	080	1.2	33	1.5	21.6	unk	Left Rear	yes	yes	Note 14
	15214	028	0.7	100	6	95.9	unk	Rear	yes	yes	
	16724	400	1.4	30	4	43.4	unk	Rear	yes	yes	
	15223	015	0.4	48	1.3	34.4	unk	Rear	yes	yes	
13	16144	028	0.07	65	unk	18.1	unk	Right rear	yes	yes	Note 15
	15227	305	0.04	10	unk	2.2	unk	Left rear	yes	no	Note 16
	15207	015	0.04	25	unk	17.8	unk	Rear	yes	Note 17	
16	NEN55	Note 6	0.2	18	1.4	110.1	none	Front	yes	yes	Note 18
	15212	080	1.4	10	unk	17.2	unk	Rear	yes	yes	
	15223	015	0.1	unk	unk	33.4	unk	Rear	yes	yes	
	15224	028	0.8	60	unk	98.1	unk	Rear	yes	yes	
	16719	400	2.0	35	2.3	45.3	unk	Middle	yes	yes	Note 19
	15145	08	1.4	18	1.0	15.5	unk	Left Rear	yes	yes	
	15190	100	1.0	10	1.0	20.9	unk	Rear	yes	yes	

Notes:

1. All locations at Purolator Terminal Atlanta, Georgia unless otherwise noted.

2. Associated Courier, St. Louis, MO to Memphis, Tn; Birmingham, AL; Atlanta, GA; Charlotte, NC; Orlando, FL; and Ft. Lauderdale, FL.

3. Vehicle monitored while parked outside terminal building; driver had not arrived from Birmingham yet. Unknown if placards were displayed when vehicle actually departed.

4. Skycab, East Brunswick, NJ to Charlotte, NC; Atlanta, GA. and Orlando, FL.

5. Skycab driver did not grant permission to monitor vehicle. After off- loading RAM for Atlanta, Ga., the driver and assistant repositioned RAM destined for Orlando, Florida towards rear of vehicle. Prior to departing terminal, driver gave permission to place a TLD behind driver's seat and driver accepted new personnel TLD. The driver said that his current TLD was in his other van. TI of 101.1 was off-loaded at Atlanta, Georgia per freight bills.

6. New England Nuclear, Billerica, MA through Nashville, TN and Atlanta, GA to Oak Ridge, TN and return to Billerica, MA. Trailer has lead shielding installed on sides and front end.

7. Vehicle was noted departing terminal without displaying placards. Subsequently, vehicle returned and driver mentioned that he displays the placards in the morning when he departs on his route.

8. LSA shipment (7.46 Ci) in cask 6722/A from Browns Ferry enroute to Barnwell, SC was monitored at rest area at I-20 near Conyers exit. Subject shipment had been used for an exercise in which GA. officials participated with TVA authorities, who called a simulated radioactive shipment accident.

9. Consolidated shipment was LSA from Emory University, Morehouse College and Georgia Institute of Technology. Upon arrival at Barnwell, S.C. it was reported that the 2-ton contaminated shield leg punctured the base of the container and slightly contaminated the trailer, which required decontamination.

10. Total TI was unknown; however, per freight bills for RAM off loaded at Atlanta, GA., TI was 104.9. Skycab driver does not have a compilation of RAM TI by destination. TI is only shown on individual freight bills. Driver's log does reflect number of pieces and weights by destination for road scale checks. Only left side of vehicle had placard displayed. Some RAM packages fell out when rear door was opened.

11. Skycab vehicle was remonitored outside terminal after driver repositioned RAM destined for Orlando, FLA. towards rear of vehicle. Reading in sleeper was 4.2 mR/Hr. TI was unknown. This Skycab driver is always cooperative. Driver wore company dosimeter on his belt.

12. Associated Courier, St. Louis, MO route now terminates at West Palm Beach instead of Ft. Lauderdale, FL

13. RAM packages were stacked very high and some appeared to have fallen from top of stack toward rear of trailer. Previously, Mo-99 Generators were stacked only four generators high.

14. Reading in cab was 3.3 mR/hr until driver and trainee moved RAM towards rear of vehicle.

15. Temporary driver was ready to depart with only two placards displayed. Discussed problem with driver who immediately displayed other two placards.

16. A new Purolator truck did not have placards. Discussed problem with driver and supervisor, who made a note to correct problem.

17. Front placard was missing. Discussed problem with driver and supervisor.

18. Driver mentioned that Oak Ridge facility was closed during past 3 weeks, hence they would pick up the cask on Tuesday.

19. Only four foot separation distance between driver and RAM.

Table 2

Site Radiation Monitoring With TLD's

TLD Location		Quarterly Exposure, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80
Terminal A, Airborne			
1C *	Office, under desk	---	15
2	RAM Area, south wall	---	33
Terminal B, Airlift Intl.			
1C	Office, on wall	M +	34
2C	Breakroom, on wall	M	M
3	Left side RAM area, on wall	51	39
4	Center RAM on wall	M	M
5	Right side RAM area, on wall	M	46
6	Pillar south/east side outbound area	24	20
7	Wall, south side Outbound area	45	43
8	Pillar, west end Outbound area	M	16
9	Pillar, west end Outbound Area	M	18
Terminal C, Delta Cargo Terminal			
1C	North wall	32	29
2C	East wall	31	30
3	Inbound RAM (Hazardous Holding area	46	38
4	Outbound RAM	19	M
5	East wall between doors 6 & 7	26	31
6	Pillar, east side opposite doors 6 & 7	32	27

Terminal D, Eastern Cargo Terminal

1	RAM Area, Terminating Bins 3 & 4	66	41
2	RAM Area, Terminating Bins 1 & 2	54	52
3C	Steel pillar, SE end of terminal	16	15
4	RAM area, Outound	22	26
5	RAM Area, Inbound on steel pillar	15	14
6	RAM Area, Terminating Bins 2 & 3	53	41
7	RAM Area, Terminating Bins 4 & 5	52	31
8	Left side of pickup door #1	30	22

Terminal E, Emery Air Freight

1C	Office, under desk	M	16
2	RAM Area on post	32	14

Terminal F, Federal Express

1C	Office	M	22 (a)
2	End of roller conveyor, east end terminal	23	21
3	Bin pkg holding area outside office	---	20

Terminal G, Flying Tigers

1C	Office	22	22
2	Wall left corner RAM area	36	98
3	On pillar center of RAM area	34	88

Terminal H, Profit by Air

1C	Office	M	17
2	RAM area, east wall	19	18
3	RAM area, post to left of east wall	20	20

Terminal I, Purolator

1C	Breakroom on water fountain	M	15
2	West wall, between door 2 & 3	34	54
3	By dispatcher's window inside cabinets	320	290
4	North wall, left side men's latrine	72	68
5	South wall, between doors 4 & 5	270	200
6	South wall, between doors 7 & 8	M	450
7	North wall, by door 16	92	62
8	South wall, between doors 1 & 2	57	35
9	East side between doors A & B	690	560
10	East side between doors B & C	560	440

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* Denotes Control TLD

\+ M: Missing

Note: a. F (1C) TLD was attached to file cabinet in office which was subsequently moved out in the terminal area in a fenced storage area.

Table 3

Summary of Weekend RAM Shipments Distribution by Purolator Courier,
Atlanta, Georgia, from New England Nuclear (NEN), Mallinckrodt (M) and Squibb (SQ)

1979 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category LTD	I	II	III	Unk.	Totals
July 28	NEN	AL	0	11	21	12.7	40.0	3	11	6	12	0	32
Sept. 1	NEN	AL	0	11	14	12.6	39.7	0	10	3	12	0	25
30	NEN	AL	0	11	20	12.3	38.3	1	11	8	11	0	31
July 28	NEN	GA	0	15	17	17.8	53.8	1	12	4	15	0	32
Sept. 1	NEN	GA		16	15	19.1	56.2	0	11	3	17	0	31
30	NEN	GA	0	16	20	19.4	58.3	1	14	4	17	0	36
July 28	NEN	FL (1)	0	3	2	4.1	12.0	0	2	0	3	0	5
Sept 1	NEN	FL (1)	0	4	2	5.9	17.1	0	1	1	4	0	6
30	NEN	FL (1)	0	5	3	7.2	21.1	1	1	1	5	0	8
July 28	M	GA	18	18	3	16.5	40.5	1	0	17	21	0	39
Sept 1	M	GA	18	19	3	17.6	40.4	3	0	16	21	0	40
29	M	GA	21	19	2	17.6	40.7	1	0	21	20	0	42
July 28	M	FL *	6	54	1	86.3	122.9	0	0	5	56	0	61
Sept 1	M	FL *	Data not available										
29	M	FL *	7	52	0	85.7	123.7	0	0	4	55	0	59
July 28	M	NC *	7	39	0	32.8	79.2	0	0	6	40	0	46
Sept 1	M	NC *	Data not available										
29	M	NC *	6	42	1	52.7	87.4	0	0	4	45	0	49
July 28	SQ	AL	6	15	2	27.4	43.8	0	0	3	20	0	23

Date	Source	Destination	I-131	Mo-99	Misc.	curie	TI	LTD	I	II	III	Unk.	Totals
Sept 1	SQ	AL	4	16	2	27.9	42.4	0	1	3	18	0	22
Sept 29	SQ	AL	1	16	2	27.3	38.3	1	0	1	17	0	19
July 28	SQ	GA	3	19	2	29.0	40.1	2	0	1	21	0	24
Sept 1	SQ	GA	1	17	4	26.1	35.8	1	0	4	17	0	22
29	SQ	GA	0	16	1	24.0	32.8	0	0	1	16	0	17
July 28	SQ	FL (1)	0	3	0	4.7	6.6	0	0	0	3	0	3
Sept 1	SQ	FL (1)	0	2	0	4.6	5.4	0	0	0	2	0	2
29	SQ	FL (1)	0	4	0	7.4	9.5	0	0	0	4	0	4
July 28	SQ	TN	5	11	1	19.5	35.0	1	0	1	15	0	17
Sept 1	SQ	TN	4	12	0	19.9	30.4	0	0	1	15	0	16
29	SQ	TN	1	11	0	18.8	26.1	0	0	0	12	0	12
Oct 27	M	NC (2)	5	42	2	41.9	85.3	0	0	4	45	0	49
Dec 1	M	NC (2)	7	43	0	41.2	79.2	0	0	3	47	0	50
15	M	NC (2)	Data Not Available----------										
Oct 27	SQ	AL	0	15	1	26.7	36.5	1	0	0	15	0	16
Dec 1	SQ	AL	0	16	1	27.2	37.8	0	0	1	16	0	17
16	SQ	AL	2	15	2	26.8	38.0	1	0	2	16	0	19
Oct 27	SQ	GA (3)	1	15	3	23.8	31.7	2	0	1	16	0	19
Dec 1	SQ	GA (3)	1	15	0	23.3	31.8	0	0	1	15	0	16
16	SQ	GA (3)	3	16	0	24.6	35.6	0	0	2	17	0	19
Oct 27	SQ	FL (1)	0	2	0	5.1	5.4	0	0	0	2	0	2

1979 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Shipment Category LTD	I	II	III	Unk.	Totals
Dec 1	SQ	FL (1)	0	2	0	5.1	5.4	0	0	0	2	0	2
16	SQ	FL (1)	0	2	0	5.1	5.4	0	0	0	2	0	2
Oct 27	SQ	TN	1	12	0	19.9	27.5	0	0	0	13	0	13
Dec 1	SQ	TN	5	12	1	20.0	29.9	0	0	2	16	0	18
Dec 16	SQ	TN	3	12	1	20.0	30.2	1	0	1	14	0	16
Oct 28	NEN	AL	0	11	19	12.9	40.3	2	12	4	12	0	30
Dec 2	NEN	AL	0	13	18	15.9	51.3	0	14	2	16	0	32
16	NEN	AL	0	10	20	12.2	40.2	5	10	2	13	0	30
Oct 28	NEN	GA	0	14	22	17.3	52.6	1	14	6	15	0	36
Dec 2	NEN	GA	0	15	28	19.4	57.2	5	14	9	15	0	43
16	NEN	GA	-	16	26	19.9	59.9	5	15	5	17	0	42
Oct 28	NEN	FL (1)	0	3	2	4.1	12.0	0	2	0	3	0	5
Dec 2	NEN	FL (1)	Data Not Available										
16	NEN	FL (1)	0	3	2	4.1	12.0	0	2	0	3	0	5
Oct 27	M	GA	20	20	0	19.3	46.3	0	0	20	20	0	40
Dec 1	M	GA	13	20	1	20.3	35.0	0	0	13	21	0	34
15	M	GA	15	20	4	20.5	38.1	1	0	15	23	0	39
Oct 27	M	FL (2)	4	51	1	89.2	121.1	0	0	2	54	-	56
Dec 1	M	FL (2)	5	54	1	91.6	117.1	0	0	2	58	0	60
15	M	FL (2)	Data Not Available										

* Purolator no longer distributes Mallinckrodt RAM to NC and FLa. Associated Courier provides this service .

Notes:
1. RAM routed through Montgomery, Alabama.
2. Mallinckrodt RAM on Associated Courier, St. Louis; tractor trailer enroute to states indicated.
3. RAM destined to Rome, Georgia and Ft. Oglethorpe, Georgia are routed to Chattanooga, TN on the express run and then sent back to the final destination.

Table 4

Summary of Weekend RAM Shipments Distribution by Purolator Courier, Atlanta, Georgia from Miscellaneous Sources

1979 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category Ltd.	I	II	III	Unk.	Totals
Oct. 27	Amersham (Profit by Air)	GA	0	0	I-125 P-32	0.010 3 unk	0.1	3	1	1	0	0	5
	Roche Diagnostics (Skycab)	GA	0	0	unk	unk	-	1	0	0	0	0	1
	Roche Diagnostics (Skycab)	AL	0	0	I-125	0.000024	-	1	0	0	0	0	1
Oct. 28	Medi Physics (Delta)	GA	0	0	Overpack I-123 Ga-67 XE-133	0.072	0.9	0	0	1	0	0	1
	Medi Physics (Delta)	GA	0	0	I-123	0.0002	0.1	0	0	1	0	0	1
Dec. 1	Benton Dickson (Profit by Air)	AL	0	0	H-3	0.005	0	0	1	0	0	0	1
	Benton Dickson (Profit By Air)	TN	0	0	H-3	0.013	0	0	2	0	0	0	2
Dec. 1	Amersham (Profit by Air)	AL	0	0	I-125	0.00077	0.2	0	0	1	0	0	1
	Amersham (Profit by Air)	GA	0	0	unk	unk	-	1	0	0	0	0	1
	Mallinckrodt (Misrouted to ATL)	AL	1	0		0.041	0.9	0	0	0	1	0	1
	Squibb (Arr ATL/Airlines)	FL	0	1		1.707	2.5	0	0	0	1	0	1
	Roche Diagnostics (Skycab)	GA	0	0	I-125	0.00004	-	4	0	0	0	0	4
	Roche Diagnostics (Skycab)	AL	0	0	I-125	0.00001	-	1	0	0	0	0	1
Dec. 2	Medi Physics (Delta)	GA	0	0	I-123	0.002	0.1	0	0	1	0	0	1

Table 5

Summary of Weekday (Thursday) RAM Shipments Distribution by Purolator Courier, Atlanta, Georgia, from Squibb (SQ) and Roche (R) (Delivered to Atlanta, Ga. by Skycab in Carrier Van)

1979 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category LTD	I	II	III	Unk.	Totals
Sept 13	SQ	AL	0	11	0	7.6	23.2	0	0	0	11	0	11
	R	AL	0	0	2	-	-	2	0	0	0	0	2
	SQ	GA	0	4	0	2.2	6.8	0	0	0	4	0	4
	R	GA	0	0	2	-	-	2	0	0	0	0	2
	SQ	FL	0	2	0	1.5	4.4	0	0	0	2	0	2
	R	FL	0	0	2	-	-	2	0	0	0	0	2
	R	KY	0	0	2	-	-	2	0	0	0	0	2
	SQ	TN	0	6	0	4.0	12.2	0	0	0	6	0	6
	R	TN	0	0	1	-	-	1	0	0	0	0	1
Sept 20	SQ	UNK	0	26	1	unk	54.2	1	0	0	26	0	27

Table 6

RAM Shipments From Georgia Institute of Technology Reactor

(November 1978 - October 1979)

Date 1978	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category Ltd	I	II	III	Unk	Remarks
Nov. 9	University of Texas	Federal Express	H-3	1.8	1.2				X		
	"	Federal Express	Kr-85	1.1							
	University of Texas	Federal Express	H-3	1.8	1.2				X		
	"	Federal Express	Kr-85	1.1							
	University of Texas	Federal Express	H-3	1.8	1.2				X		
	"	Federal Express	Kr-85	1.1							
Nov. 15	Med. Research Foundation, GA	Hand Carried	Y-90	2.6	0.5		X				
Nov. 22	Florida State University	Federal Express	P-32	0.0001	0.1			X			
	University of Arkansas	Federal Express	K-42	0.0001	0.2			X			
Nov. 29	Applied Physical Tech., GA.	APT. Vehicle	Co-60	0.0007	0.1			X			
Dec. 4	University of Arkansas	U.S. Mail	Act. Products	Trace	-	X					
Dec. 6	University of Florida	Federal Express	Na-24	0.003	0.2			X			
Dec. 12	Florida State University	Federal Express	Mo-99	0.0002	0.2			X			
Dec. 13	Med. Research Foundation, GA	Hand Carried	Y-90	0.75	0.8			X			
	DOE Idaho Falls, ID	Delta Al	Fe-55 P-32	1 uci	-	X					Fish
Dec. 18	Med. Research Foundation, GA	Hand Carried	Y-90	0.080	0.6			X			
Dec. 21	University of Florida	U Haul U. FL. Vehicle	Co-60	1 uci	-		X				

Date 1978	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category Ltd	I	II	III	Unk	Remarks
1979											
Jan. 5	University of Florida	U. FL. Vehicle	Co-60	0.0002	0.1			X			
Jan. 15	Med. Research Foundation, GA	Hand Carried	Y-90	1.4	0.7			X			
Jan. 22	University of Nebraska	Fed. Express	Na-24	0.0001	-		X				
	Florida State University	Fed. Express	P-32	10 uci	-		X				
Jan. 31	Med. Research Foundation, GA	Hand Carried	Y-90	0.1	0.2			X			
Feb. 1	Georgia State University	Hand Carried	Tb-161	30 uci	0.5			X			
Feb. 9	Emory University, GA	Hand Carried	Zn-69	0.001	3.0			X			
	Georgia Marine Institute, GA	U.S. Mail	C-14	0.00001	-	X					
Feb. 12	U.S. EPA, AL	Greyhound Express	Fe-55	1 uci	-	X					Fish
Feb. 13	Med. College of Georgia	Hand Carried	F-18	0.0045	1.5			X			
Feb. 14	Med. Research Foundation, GA	Hand Carried	Y-90	0.63	0.5			X			
Feb. 21	Med. Research Foundation, GA	Emery Air Freight	Y-90	1.7	1.0			X			
	SRP, SC	Personal Vehicle	Ta-182	0.005	0.8			X			
Feb. 27	New York University	Fed. Express	H-3	1.4	-		X				
Feb. 28	University of Arkansas	U.S. Mail	Act. Products	Trace	-	X					
March 6	Bell Telephone, PA	Fed. Express	Cd-115	0.0005	0.1			X			
	University of Arkansas	U.S. Mail	Fe-59	Trace	-	X					
March 7	Bell Telephone, PA	Fed. Express	Ru-103	50 uci	0.1			X			
March 9	University of Kentucky	Ky. Vehicle	Na-24	0.0006	0.5			X			

Date 1978	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category Ltd	I	II	III	Unk	Remarks
March 9	University of Kentucky	UKY Vehicle	Na-24	0.001	0.9			X			
March 21	Med. Research Foundation, GA	Hand Carried	Y-90	2.0	0.8			X			
March 29	University of Arkansas	Fed. Express	H-3	0.0005	0.2			X			
	SRP, SC	SRP Veh	Ta-182	0.005	0.8			X			
April NONE											
May 16	University of Arkansas	U.S.Mail	Zn-65	0.0009	-	X					
May 24	Med. College of Georgia	Hand Carried	F-18	0.003	0.5			X			
May 28	University of Florida	Univ Truck	Co-60	10 uci	0.7			X			
May 31	University of Arkansas	ABF Truck Line	H-3	0.0008	0.6			X			
Jun 5	SRP, SC	Georgia Tech Veh	Co-60	7 uci	0.1			X			
Jun 12	Babcock & Wilcox, VA	Fed. Express	Depleted U	700 grams	0.2			X			
	" " "	Fed. Express	Th-232	0.00016							
Jun 15	University of Arkansas	ABF Truck Lines	Zn-65	0.0002	0.9			X			
Jun 18	United Tech Research Center, CT	Fed. Express	Cr-51	1 uci	-	X					
Jun 29	University of Georgia	State Vehicle	C-14	0.005	0.1			X			
July 6	United Tech Research Center, CT	U.S. Mail	Cr-51	0.001 uCi	-						Exempt

Date 1978	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category Ltd	I	II	III	Unk	Remarks
July 12	**University of Arkansas**	**U.S. Mail**	**Zn-65**	0.0001	-	X					
July 25	E. I. DuPont, Savannah River, SC	Ga. Highway Express	Ta-182	0.0001	2.0				X		
Aug. 3	University of Texas	Fed. Express	Kr-85 H-3	0.13 0.54	0.5			X			
	" " "										
	University of Florida	Fla. Vehicle (Sole Use)	Co-60	0.0003	1.5			X			
Aug. 6	Proctor & Gamble, OH	Fed. Express	Na-24	0.002	0.3			X			
Aug. 9	United Tech Research Center, CT	Fed. Express	Cr-51	15 uci	0.1			X			
	" " " "	Fed. Express	Cr-51								
Aug. 15	E.I. DuPont SRP, SC	Overnite	Cr-51	0.0001	0.2			X			
Aug. 21	Med. College of Georgia	Hand Carried	F-18	0.003	0.7			X			
Aug. 23	E.I. DuPont ,SRP, SC	Hand Carried	H-3	0.31	-		X				
Sept. 5	Applied Physical Tech, Georgia	APT. Personal Vehicle	Co-60	0.0007	0.4			X			
Sept. 7	University of Texas	Fed. Express	Kr-85 H-3	0.10 0.88	0.4			X			
	University of Texas	Fed. Express	Kr-85 H-3	0.08 0.88	0.4			X			
Sept. 7	Center for Neurochemistry, NY	U.S. Mail	H-3	0.0001	-	X					
Sept 10	Bureau National de' Metrologie, France	Aircraft	Ba-133	4 uci	0.1		X				
	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0005	0.5			X			

Date 1978	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category Ltd	I	II	III	Unk	Remarks
Sept 10	University of Arkansas	U.S. Mail	LSA (Activation Products)	-	-	X					No labels Required
	University of Miami	U.S. Mail	Zn-69	5 uci	-	X					No labels required
Sept 11	Applied Physical Tech, GA	APT. Personal Vehicle	Co-60	0.0007	0.4			X			
Sept 17	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0005	0.2			X			
Sept 24	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0003	0.7			X			
Oct. 1	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0002	0.5			X			
Oct. 3	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0002	0.9			X			
	Proctor & Gamble, OH	Fed. Express	Na-24	0.0005	0.3			X			
Oct. 4	University of Arkansas	U.S. Mail	LSA	-	-	X					No labels required
	U.S. Army Engineers MS	Fed. Express	Kr-85	0.3 uCi	-	X					
	Med. Research Foundation GA	Hand Carried	Y-90	0.328	0.3			X			
Oct. 5	Law Eng. & Testing, GA	Hand Carried	Kr-85	9.uCi	0.1	X					
	Med. Research Foundation, GA	Hand Carried	Y-90	0.0004	0.4			X			
Oct. 8	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0004	0.9			X			
Oct. 10	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0004	1.3				X		
Oct. 11	Health Physics Off. University Park, PA	Unknown	H-3	0.002	-		X				
Oct. 12	Univ. of Texas	Fed. Express	H-3	2.88	1.9				X		
			Kr-85	0.81							

Date 1978	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category Ltd	I	II	III	Unk	Remarks
Oct. 15	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0006	1.6				X		
Oct. 17	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0004	1.7				X		
	University of Kentucky	U. Ky. Vehicle	Na-24	50 uCi	0.2			X			
Oct. 18	Florida State University	Fed. Express	Sm-153	0.0001	2.0				X		
Oct. 19	Emory University, GA	Hand Carried	Cd-111m Br-80	0.0005 0.020	unk			X			
Oct. 22	Sunoco Products, SC	Fed. Express	Kr-85 H-3	2.2 } 5.0 }	5.0				X		
	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0002	0.1			X			
Oct. 23	Sunoco Products, SC	Emery Air Freight	Kr-85 H-3	2.2 } 5.0 }	6.0				X		
	U.S. Geological Survey, VA	Fed. Express	Na-24	200uci	0.3			X			
Oct. 24	Sunoco Products, SC	Emery Air Freight	Kr-85 H-3	2.2 } 5.0 }	5.0				X		
	University of Arkansas	Fed. Express	Pa-233	15 uCi	0.2			X			
	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0002	0.7			X			
Oct. 25	Wyle Lab, Huntsville, AL	U.S. Mail	Activation Products	-	-	X					
Oct. 26	University of Texas	Fed. Express	Kr-85 H-3	1.16 } 1.26 }	1.8				X		
	University of Texas	Fed. Express	Kr-85 H-3	0.74 } 1.70 }	1.0				X		
Oct. 29	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0004	0.9				X		
Oct. 31	U.S. Geological Survey, VA	Fed. Express	Na-24	0.0004	1.2				X		

Table 7

RAM Shipments from Georgia Institute of Technology Reactor
To Barnwell, South Carolina for Burial

Date	Shipping Mode	Isotope	Activity, curie	TI	Remarks
January 1979					
18	Thurston Transportation Company	LSA	unk	-	Combined shipment-Ga. Tech 62 pieces, Emory 205 pieces, Morehouse 11 pieces Total 279 pieces
April 1979					
17	Thurston Transportation Company	LSA	unk	-	Combined shipment-Ga. Tech 22 pieces, Emory 147 pieces, Morehouse 7 pieces Total 176 pieces
October 1979					
18	Home Transportation Company	RAM Waste Sr-90	47.724	-	Cask CNSI 15-160B Secured to Trailer

Table 8

Surface Contamination Measured By Smears of Vehicles and RAM Packages
(At Purolator Courier, Atlanta, Georgia Unless Otherwise Noted)

Date 1979	Area, cm^2	Object Smeared	Radionuclide Level, pCi/100 cm^2					
			Se-75	Mo-99	I-131	Co-57	Cs-137	Co-60
May 5	103,000	# Mo-99, 10 packages, Mallinckrodt	0.02	0.12	0.01	-	-	-
July 28	12,000	I-131, 9 packages, Mallinckrodt	0.02	<0.02	<0.02	-	-	-
	14,000	Mo-99, 9 packages, Mallinckrodt	0.06	<0.02	<0.02	-	-	-
	5,000	Associated Courier Vehicle Steering Wheel and Rear of Trailer Bed	0.32	<0.02	<0.02	0.06	-	-
Sept. 1	15,000	Mo-99, 9 packages, Mallinckrodt	0.02	0.11	<0.02	0.01	-	-
	13,000	I-131, 9 packages, Mallinckrodt	<0.02	<0.02	0.06	-	-	
8	400	Spent Fuel NL Trailer #73372, Turkey Point to Ohio. Tri-State Transportation Company	<1	-	<1	0.5	1.9	5.3
20	5,600	Skycab Veh. 532 KOG, Rear of Bed	<0.03	<0.02	0.075	-	-	-
29	8,300	Mo-99, 5 packages, Mallinckrodt	0.12	0.11	-	0.02	-	-
	20,000	Mo-99, 4 packages, Squibb	0.02	<0.02	<0.02	-	-	-
	5,600	Associated Courier Trailer, Rear of Bed	0.86	0.11	-	0.16	-	-
October 27	5,600	Associated Courier Trailer, Rear of Bed	0.7	0.1	<0.1	0.2	-	-
28	3,000	NEN Trailer, Rear of Bed	<0.02	<0.02	<0.02	0.05	-	-
Dec. 1	1,900	Associated Courier Trailer, Rear of Bed	0.54	<0.2	0.21	0.13	-	-
	520	Associated Courier Assistant Driver, Bottom of Shoes	1.0	0.24	0.34	0.19	-	-

APPENDIX A: OBSERVATIONS

1. On October 16, Mr. Powell of Florida Power and Light called to advise that two shipments of spent fuel have been rerouted through Atlanta, GA to by-pass Louisiana, to depart this date. Subsequent shipments from Turkey Point to Nevada will also be routed through GA.

2. On October 25, a meeting was held with supervisory personnel at Easter Cargo Terminal to discuss problem with individual who was issued TLD #5. Subject TLD was found at Purolator and had a reading of 36 mR for the period September 27-30, 1979. The TLD for August and September showed 34 mR. It was the consenus that subject individual placed the TLD on a RAM package. Subsequently, in meeting with subject individual the importance of the study was stressed to gather factual data for individual doses. TLD #5 for individual for period October 25 to December 13, 1979, had a reading of 9.3 mR, which is in range of other personnel doses.

3. On October 27 at Purolator Terminal, a Mallinckrodt RAM package, Bill #J026483 containing I-131, 0.013 Curie, TI 0.4, destined for Memorial Medical Center, Savannah, Georgia, had Y III labels while bill of lading showed labels as yellow II.

4. On October 27 at Purolator Terminal, the Skycab driver delivering Squibb RAM would not give permission to monitor his vehicle. No readings were obtained. Other Skycab drivers have been cooperative. The driver claimed that two other Skycab drivers had been hospitalized for radiation exposure, but this could not be verified. On December 1, 1979, Skycab vehicle was monitored and driver was cooperative.

5. On October 27 at Purolator Terminal, the Associate Courier Trailer delivering Mallinckrodt RAM again showed reading over 10 mR at six feet from surface. This was discussed with drivers.

6. On October 27, 1979 at Purolator Terminal, undeveloped film was found near east end of terminal where the exposure rate reading was 0.5 mR/hr. On October 28, a dolly containing Dyna Color Film was located at south end of terminal where the expoure rate reading was 0.7 mR/hr. Box was marked "Do Not Xray". On December 1, a dolly with film was located at east end of terminal where the exposure rate reading was 2.5 mR/hr. Squibb RAM was 17 feet away. The supervisors were informed and immediately moved the film.

7. On November 27, 1979, a simulated accident involving a RAM shipment of waste from the Browns Ferry, Alabama, Nuclear Power Plant enroute to Barnwell, South Carolina was held on I-20 at Conyers rest area. The exercise was designed to test alert notification and response. Local police, firemen, local and state officials and TVA officials participated. Local news and TV stations covered the exercise.

8. On November 29, it was learned that a RAM package had been run by a forklift at Kenworthy Air Freight at North Cargo Building, Atlanta, Georgia. Georgia EPD-DNR staff responded. The package, White 1 labels, containing H-3, 12.25 mCi and C-14, 100 uCi was crushed, but the vials remained intact. No contamination was found on swipes of vials. The package had been shipped from Becton Dickinson Immuno Diagnostics, Orangeburg, New York to Gainesville, Florida. The package was recovered by Profit by Air representative for repackaging.

9. On December 1 at Purolator Terminal, two RAM packages of I-131 from Squibb were checked. Both boxes had yellow III labels with a recorded TI of 0.3. Box #31265F had recorded activity of 0.009991 curie and other box #31298F had activity of 0.01 curie. The freight bill on later box had recorded 0.006470 curie for the activity.

10. On December 1 at Purolator Terminal, a package containing H-3 from Becton Dickinson was checked and it was noted that a Profit by Air envelope partially covered one of the white I labels. Action will be taken next quarter to contact Profit by Air representative to make them aware of the problem with envelopes and air bills covering the labels.

11. On December 2 at Purolator Terminal, two RAM packages from New England Nuclear were checked. Ga-67 package to University Hospital, Augusta, Georgia had yellow II labels, with TI of 0.5 and 0.018 curies; however, the bill of lading reflected yellow III labels with TI of 1.0. A Co-57 package to Memorial Hospital Waycross, Georgia had yellow II labels with TI of 0.1 and 0.005 curies; however, bill of lading reflected TI of 0.2 and 0.003 curies.

12. On December 4, information was received from the Georgia Environmental Protection Division, Department Natural Resources, that a shipment of nuclear waste from Plant Farley, Alabama enroute to Barnwell, SC was involved in a minor traffic accident in Albany, Georgia on October 22, 1979. The accident was minor and no damage was sustained to the cask.

13. On December 13, 1979, at Purolator Terminal, it was noted that an Amersham RAM package with Y II labels had a Profit by Air air-bill envelope over one label and a Profit by Air label partially covering the other yellow II label. The purchase order number was B908157 to University of Alabama.

Mr. Decker
B10-659

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TO: Dr. Wayne Schumann, Director Attn: Mr. Willard Ingram
Radiological-Occupational Health Unit, Georgia DHR

FROM: Dr. Bernd Kahn, Director
Environmental Resources Center

DATE: May, 12, 1980

SUBJ: Sixth Quarterly Report of Progress (January 1-March 31, 1980) of Extended State Transportation Surveillance Program - Radioactive Materials - under agreement between Georgia Department of Human Resources and Georgia Institute of Technology

Observations of RAM transportation and associated radiation exposures were continued by monitoring radiopharmaceutical packages and the vehicles that carried them, determining the exposures of workers who handled the RAM and drove the vehicles, and recording the origins, numbers, and destinations of these shipments. In addition, in response to request by US DOT staff, the exposure rates from typical Mo-99 containers, which usually constitute the major source of radiation exposure, were measured as a function of storage configuration and distance.

The list of monitored RAM packages is given in Table 1. Problems encountered are summarized in Appendix A. On two occasions, photographic film was located too near stored RAM. Smears from one damaged shipment were found to be low in contamination. No situations leading to serious radiation exposure to persons were observed.

Radiation exposures of workers measured for approximately 14 weeks on a continuing basis are shown in Tables 2a - 2h. The expected background exposure rate of 1-2 mR/week would contribute 14-28 mR in this period. Tables 2e-2h contain some elevated exposures. Of the nine workers with elevated exposures at the Purolator terminal (Table 2e), only #100 had values that could lead to significantly elevated annual exposures; procedures for exposure reduction were discussed with this individual. The three sets of drivers of RAM for which exposures are reported in Tables 2f-2h would all receive between 500 and 5,000 mR per year due to RAM if continuing at the present rate.

The vehicle monitoring results with TLD's shown in Table 3 indicate 4 vehicles with noticeably elevated radiation level at the back of the driver's seat, where the TLD's are located. These correspond to elevated personnel TLD's reported above. Monitoring with survey meters, for which results are given in Table 4, found one instance

of dose rate above 2 mrem/hr at the driver's seat.

The radionuclide contents of several smears taken during surveys of vehicles and packages are listed in Table 5. All other smears taken during surveys had no detectable radionuclides.

Descriptions of the amounts of some shipments of radionuclides passing through Georgia are given in Tables 6-9. A reduction in number of RAM packages handled by Purolator was noted as some of the carriers from the three radiopharmaceutical suppliers transported RAM directly to their destination.

Mo-99 RAM generator packages that were available at uniform TI values at Purolator while stored for distribution on February 24, 1980, were used to determine the exposure rate as function of distance and box configurations. The measurement was performed with a Jordan "Rad-gun" ionization chamber detector. Each package was measured to determine the TI and was then placed on a wooden cart for the study. Measurements were obtained at the center line perpendicular to the configuration at 3-foot intervals from the surface. The background, which was in the range 0.04-0.07 mR/hr, was subtracted from each reading. From 1 to 9 boxes were placed side by side. The boxes were also stacked two and three high and side by side with one line of boxes behind the other. The number of configurations was limited by the availability of these boxes. Mr. Will Ingram, Georgia DHR, participated in these measurements.

The results, shown in Table 10, indicate the expected uniform increase with number of boxes and decrease with distance between detector and source. The exposure rate increases unevenly only at the surface, where the effect is seen of measuring at the center of the box for a line of odd boxes and between boxes when the number is even. Two values that are clearly out of line (marked by asterisks) were eliminated from further data analysis. The computed mR/hr values per TI, shown in Table 11, are almost independent of configuration within even 3 feet when up to 10 containers are distributed variously. This is shown by the means given in Table 11 and by these means graphed as function of distance squared (taking the distance to be from the center of the box to the center of the detector) in Figure 1. The line, drawn to give an inverse square relation, fits the averages of measured values between 3 and 18 feet. It is also consistent with the exposure rates measured at the surface of single containers, although mR/hr per TI values for multiple containers are less. Hence, this line can be used to estimate exposure rates or exposure time limits as a function of TI and distance. Note that the average mR/hr per TI at the 3 foot distance is only approximately 0.8 instead of 1.0 because these values were measured at a specified location (on the perpendicular) while the TI was measured at the location of maximum reading.

As indicated in Table 12, a second row of Mo-99 generators contributes noticeably to the measured mR/hr per TI in that row to the extent of 16

percent of the front row, on the average. On this basis, an identical third row would contribute 3 percent, and further rows would not be measurable. Hence, the mR/hr per TI read from Figure 1 should be multiplied by 1.16 for two rows, and by 1.19 for three or more rows of identical TI's relative to the number of TI's in front.

The monitoring and dosimetry program, concentrating on radiopharmaceutical shipments, is being continued, especially with respect to the new transportation arrangements currently being made by shippers.

BK:bjs

Table 1

Monitored RAM Packages*

Date	Amount, Ci	Isotopes	Transportation Index	Category LTD	I	II	III	Remarks**
February 1980								
24	0.75	Mo-99	2.3				1	(1.0)
	1.35	"	4.0				1	(2.2)
	1.35	"	4.0				1	(2.1)
	1.35	"	4.0				1	(2.3)
	1.35	"	4.0				1	(2.3)
	1.35	"	4.0				1	(2.2) AL
	1.35	"	4.0				1	(2.2) AL
	1.35	"	4.0				1	(2.2) FL
	1.35	"	4.0				1	(2.2)
	1.35	"	4.0				1	(2.2)
	1.35	"	4.0				1	(2.2)
	2.9	"	6.2				1	(2.3)
	2.9	"	6.2				1	(2.0)
	1.7	"	5.2				1	(2.2)
	1.7	"	5.2				1	(2.1)
	1.7	"	5.2				1	(2.3)
	1.7	"	5.2				1	(2.1) AL
	1.7	"	5.2				1	(2.2) AL
	1.7	"	5.2				1	(2.5) AL
March 1980								
20	0.38	"	1.4				1	(0.6)
	0.010	I-131	0.4			1		(0.2)
21	0.006	I-131	0.2			1		(0.1) TN
	6.2 uci	Co-57	0.1			1		(0.1) KY (overpack)
	0.005	Co-57	0.1			1		(0.1) AL
	0.005	I-125	0.1			1		(0.1) AL
	0.002	H-3	-		1			-
	10 uci	unknown	-	1				-
	0.0011	Cr-51	0.1			1		(0.1) TN
	0.021	I-131	0.7			1		(0.3) AL
	6.4 uci	Co-57	0.1			1		(0.1)
23	1.7	Mo-99	5.2				1	(2.3)
	2.8	"	6.2				1	(1.7)
	2.8	"	6.2				1	(1.7)
	1.7	"	5.2				1	(2.0)
	1.7	"	5.2				1	(2.2)
	2.2	"	6.0				1	(3.3)
	1.8	"	5.0				1	(2.7)
	2.0	"	2.3				1	(1.3)

(Table 1 continued)

Date	Amount, Ci	Isotopes	Transportation Index	Category LTD	I	II	III	Remarks**
	0.75	"	2.3				1	(1.0)
25	0.005	I-131	0.3				1	(0.3)
	3.0	Mo-99	2.0				1	(1.5)
	0.006	I-131	0.4				1	(0.4)
	0.001	Cr-51	0.1			1		(0.1) AL
	0.012	Ga-67	0.1			1		(0.2) AL
	0.0001	H-3	-		1			- AL
29	1.7	Mo-99	5.2				1	(0.1) TN+

*RAM monitored at Delta Cargo Terminal on March 20 and 21, at Profit by Air Terminal on March 21, and at Purolator Courier terminal at all other times.

**Inbound RAM destination is Georgia unless otherwise noted. Figure in parenthesis reflects the package TI measured on the date the package was monitored. In some cases, the measured TI represented 48 hours decay time since the TI was assigned by the manufacturer. Packages with 2.8 or more curies weighed 12 pounds more.

+ Squibb Mo-99 generator to Nashville Metro Hospital, TN was returned to Purolator Courier, Atlanta, Georgia. Freight bill 31282I was annotated "REFUSED 3/17/80 return to Skycab." Package was subsequently picked up by Skycab on March 29.

Table 2a

Federal Express Personnel Radiation Monitoring with TLDs

		Exposure rate, mR/period
TLD #	Position	12/13/79 to 3/20/80
1 A	Night Ramp Agent	19.

Table 2b

Delta Cargo Terminal Personnel Radiation
Monitoring with TLDs

TLD#	Shift	Position	Exposure rate, mR/period 12/13/79 to 3/20/80
1	(B)	Clerk (office on 2nd floor) (Control)	25 (21 weeks)
3	(C)	CSA Add-to/Spec Ser and Inbound	14
4	(C)	Gate Agent, Main Terminal	NR*
5	(C)	Unloading Aircraft, Main Term.	NR
6	(A)	SCSA	56 (58 weeks)
6A	(A)	SCSA Spec Ser Agent	14
7	(C)	CSA Add-to	16
8	(A)	CSA Sorter	15
9	(C)	Ticket Counter, Main Terminal	25 (21 weeks)
9A	(C)	SCSA Spec Ser Agent	16
10	(D)	SCSA Floor	16
11	(D)	SCSA Spec Ser Agent	20
12A	(D)	SCSA Add-to/outbound	NR
13	(D)	SCSA Sorting Area	NR
16	(C)	Spec Ser Agent	16
17	(C)	Spec Ser Agent	17
18	(D)	SCSA	NR
19	(D)	SCSA	18
20	(E)	Gate Agent, Main Terminal	NR
21	(C)	Senior Ser Agent	NR

Shift: (A) 2315-0700 (B) 0800-1700 (C) 1500-2330 (D) 0700-1515

*NR - not recovered

Table 2c

Eastern Cargo Terminal Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/20/80
1	Ramp Service (1620-0020)	16
2	Ramp Service (1620-0020)	14
3	Ramp Service (0010-0810)	17
4	Supervisor (0800-1700)	21
5	R/S Front door and belt man (1620-0020)	22
6	Lead Ramp Service (0010-0810)	15
7	Ramp Ser Air Express (0900-1730)	19
8	Ramp Ser Air Express (0110-0910)	28 (21 weeks)

Table 2d

Profit By Air Terminal Personnel Radiation Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/20/80
1	Driver, Atlanta area	20
2	Driver, Atlanta area	18

Table 2e

Purolator Courier Personnel Radiation
Monitoring with TLDs

TLD #	Position (Route)	Exposure rate, mR/period 12/13/79 to 3/20/80
1	Office Secretary (Control)	14
3	Driver (028)	30 (21 weeks)
4	Driver (039)	65
6	Driver (014)	36
7	Weekend Dispatcher (supervisor)	54
10	Driver (086)	NR
11	Driver (037 & 086)	14 (4 weeks)
12	Driver and Terminal Sorter	52
14	Supervisor	19
15	Terminal Sorter	NR
18B	Driver (002)	22
19A	Driver (305)	17
36A	Driver/Supervisor	19
39	Driver (035)	30 (21 weeks)
43	Driver (008)	NR
45	Driver (100)	NR
46	Driver (400)	76
47A	Driver (045)	21
48	Driver (001)	14
49	Driver (016 & 004)	23
53	Driver (103)	NR
56	Sorter, weekends	NR
60	Driver (100 & 108)	NR
63	Driver (011)	19
67	Driver (024)	40

Table 2e

68	Driver (051)	NR
70	Sorter, week nights	74
74	Air Express	NR
75	Driver (400)	NR
76	Driver (005)	22
77	Driver (006)	20
83	Supervisor, weekend	28
84	Sorter, week nights	22
89	Driver (001)	21
90	Driver (080)	NR
93	Driver (015)	NR
95	Driver (022)	NR
96	Driver (080)	34
99	Driver (008)	NR
100	Sorter, weekend	53 (4 weeks)

Note: NR-not recovered

Table 2f

Associated Courier Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/29/80
52	Driver	650 (21 weeks)
73	Driver	900 (22 weeks)
104	Driver	-

Note: 1. Route-St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC, to West Palm Beach, FL.

2. Drivers sometimes switch to a Texas route from St. Louis, MO.

Table 2g

New England Nuclear Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/16/79 to 3/30/80
1	Driver	1100 (22 wks)
4	Driver	855 (22 wks)
5	Driver	NR
6	Driver	NR

Note: 1. Route - Billerica, MA; Atlanta, GA; Nashville, TN; Oak Ridge, TN; to Billerica, MA.

2. Drivers alternate on weekend trips.

3. NR - not recovered.

Table 2h

Skycab Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/15/79 to 3/22/79
50	Driver	NR
59	Driver	1300

Note: 1. Route - New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA; to Orlando, FL.

2. NR - not recovered.

Table 3

Vehicle Radiation Monitoring with TLDs

TLD #	Vehicle #	Route ID	Exposure rate, mR/period 12/13/79 to 3/20/80
	Purolator		
20	15180	(015)	NR
22	15181	(028)	22
23	15170	(039)	24
24	15171	(015)	NR
25	15147	(a)	NR
26	15201	(086, 039)	30
27	15207	(014)	16
28	15194	(305)	39 (25 weeks)
29A	15182	(086)	36 (21 weeks)
30	16144	(028)	NR
32	56078	(b)	NR
33	37064	(018)	NR
34	15165	(024, 037, 080, 039)	NR
35A	15174	(081)	22
38	16111	(a)	NR
40	15149	(035)	34
44	15145	(008)	NR
54	15203	(080)	30
57	15208	(100)	NR
61	16725	(400)	NR
62	15205	(008)	85 (38 weeks)
64	15178	(011)	NR
65	912	(039)	22
66	15209	(081)	45
69	15186	(051)	19
72	15192	(081)	21
81	15218	(100	NR
85	15214	(028)	80
86	16724	(400)	580 (26 weeks)
91	15289	(080)	NR
92	15227	(305)	14
94	15223	(015)	47
97	15212	(080)	43
98	15224	(028)	29
	Associated Courier		
87	P83094	(c)	580 (21 weeks)
	New England Nuclear		
3	55	(d)	415

Table 3 continued -

88	Skycab XRC92U	(e)	1400

Note: (a) Atlanta to Birmingham, AL
(b) Atlanta To SC
(c) St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC to West Palm Beach, FL
(d) Billerica, MA; Atlanta, GA; Nashville and Oak Ridge, TN
(e) New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA; to Orlando, FL

NR - not recovered

Table 4

Vehicle Monitoring Results

Date	Location	Vehicle #	Route	Radiation Levels (mrem/hr) Cab	Surface	Six ft	Transport Index	Excessive Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
February, 1980												
24	Note 1	NEN55	(A)	0.3	16	2.2	153	none	Front	yes	yes	
				0.8 (sleeper)								
		15202	103	0.4	5	unk	3.5	unk	Rear	yes	yes	
		15217	080	1.2	12	1.4	33.1	unk	Rear	yes	yes	
		16724	400	0.7	12	1.2	38.9	none	Rear	yes	yes	
		15188	012	0.2	3	0.2	2.5	unk	Left Rear	yes	yes	
		15214	028	0.4	30	3.7	38.2	none	Rear	yes	yes	
		15223	015	0.1	28	1.4	31.4	none	Rear	yes	yes	
March, 1980												
20		15231	028	0.03	0.2	0.06	0.3	unk	Rear	yes	NA	
21		15207	014	0.02	0.02	0.02	0.1	unk	Middle	yes	NA	
		15231	028	0.04	0.6	0.03	0.9	unk	Middle	(2)	NA	
23		15223	028	0.3	27	1.2	29.2	unk	Rear	yes	yes	
		16724	400	0.1	28	1.2	24.8	unk	Left Rear	yes	yes	(3)
		15214	15	0.2	20	1.5	26	unk	Rear	yes	yes	
		15210	101/103	0.9	14	1.6	24	unk	Rear	yes	yes	
		15205	008	0.9	10	0.6	11.4	unk	Left Rear	yes	yes	
25	Eastern Cargo	15149	035	0.4	10	unk	5.2	unk	Rear	yes	(4)	
		15207	014	0.3	10	0.2	2.6	unk	Right Rear	yes	yes	
		15227	108	0.03	0.2	unk	0.5	unk	Rear	yes	NA	
29		P83094	(B)	0.8	74	9.8	146.3	Table 5	Middle	yes	yes	(5)
				1.0 sleeper								
		XRC92U	(C)	2.5	80	8.8	unk	none	Full	(7)	yes	

Table 4 continued-

	XRC92U	(C)	1.5	58	5.8	unk	none	Full	(7)	yes	(6)
30	NEN55	(A)	0.1 0.2 sleeper	12	1.5	116.3	Table 5	Front	yes	yes	

Notes: A. NEN - Billerica, MA; Alexandria, VA; Charlotte, NC; Atlanta, GA; Nashville, TN to Oak Ridge, TN and return to Billerica, MA.
B. Associated Courier-St Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC; to West Palm Beach, FL.
C. Skycab-New Brunswick, NJ to Florida, Georgia, Alabama and Tennessee.

(1) All locations at Purolator Terminal, Atlanta, GA unless otherwise noted.
(2) Profit by Air manifest provided to Purolator driver only listed "Med Test Kits" for two RAM with yellow II labels and TI of 0.1 each.
(3) Driver on Macon route 400 took only Squibb RAM and all freight bills, therefore next driver would not have any shipping papers for remaining RAM at TI of 33.2. Purolator operated two vehicles on same route to keep TI on vehicles below TI of 50.
(4) Driver was ready to depart while only displaying front and rear placards on vehicle. Discussed problem with driver who then displayed side placards also. Discussed problem with driver's supervisor.
(5) After monitoring vehicle, it was noted that Skycab driver loaded Squibb RAM destined for Orlando, Florida on Associated Courier Trailer. Remonitored cab: reading did not increase with additional RAM.
(6) Readings were taken after Florida and Georgia RAM were off-loaded: TI of 69.9 offloaded for Georgia and 19.8 for Tennessee per freight bills.
(7) Skycab driver is not provided a consolidated bill that lists isotope, activity, and TI for each destination; driver is only provided with individual freight bills.

Table 4 continued

Purolator Route Code	
001	Atlanta To Cartersville/Chatsworth/Dalton
002	Atlanta to Ducktown, TN
004	Atlanta to Toccoa, GA
005	Atlanta to Elberton, GA
006	Atlanta to Milledgeville, GA
008	Atlanta to Columbus, GA
011	Atlanta to Austell, GA
014	Atlanta to Chattanooga, TN
015	Atlanta to Chattanooga, TN (Express)
016	Atlanta to Gainesville, GA
018	Atlanta to Charlotte, NC (Express)
024	Atlanta Area
028	Atlanta to Montgomery, AL (Express)
035	Atlanta Airport; weekdays
037	Atlanta Area
039	Atlanta to Macon, GA
045	Atlanta to Hartwell, GA
051	Atlanta to Pine Mountain, GA
080	Atlanta Area Hospitals
086	Atlanta Area
091	Atlanta Area and Airport
100	Atlanta to Augusta, GA
103	Atlanta to Ft. Gordon, GA
108	Atlanta to Ft. Gordon, GA
305	Atlanta to Macon, GA (Express)
400	Atlanta to Macon, GA (Express)

Table 5

Surface Contamination Measured By Smears of Vehicles and RAM Packages

Date, * 1980	Area, cm^2	Object Smeared	Radionuclide Level, pCi/100 cm^2			
			Se-75	Mo-99	I-131	Co-60
February 24	13600	10 NEN Mo-99 boxes	< 0.01	0.04	< 0.02	-
March 19 (UPS, Atlanta)	100	ionization source boxes	-	-	-	1.70
March 21 (Purolator and Delta)	25,000	5 Squibb I-131 (2) Cr-51 (1) Co-57 (2)	0.02	< 0.02	< 0.02	-
March 23	2800	2 NEN Mo-99	< 0.1	0.24	< 0.1	-
March 29	2100	Associated Courier Trailer bed	0.15	< 0.1	< 0.1	-
March 30	1390	NEN Trailer bed	< 0.1	1.5	< 0.1	-
April 26	2800	Associated Courier Trailer bed	0.13	0.10	< 0.1	-

*At Purolator Courier, Atlanta, Georgia unless otherwise noted.

Table 6

Summary of Weekend RAM Shipments Distribution by Purolator Courier,
Atlanta, Georgia, from New England Nuclear (NEN), Mallinckrodt (M) and Squibb (SQ)

1980 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	LTD	Category I	Category II	Category III	Unk.	Totals
Feb. 24	NEN	AL	0	11	22	11.6	38.9	3	13	3	14	0	33
	"	GA	0	18	22	23.7	66	1	15	6	18	0	40
	"	FL (1)	0	3	3	4.1	12.0	1	2	0	3	0	6
Mar. 23	"	AL	0	11	17	11.8	40.0	0	13	1	14	0	28
	"	GA	0	16	21	20.3	60.7	1	12	8	16	0	37
	"	FL (1)	0	3	3	4.5	13.1	0	2	1	3	0	6
Mar. 30	"	AL	1	11	22	11.2	34.0	1	14	5	14	0	34
	"	GA	0	14	23	17.6	52.2	8	12	3	14	0	37
	"	FL (1)	0	3	2	4.5	10.0	0	2	0	3	0	5
Feb. 24	M	GA	17	19	8	20.3	34.8	5	0	19	20	0	44
	"	FL (2)	Data not available										
	"	NC (2)	Data not available										
March 23	"	GA	15	20	7	21.4	36.9	4	0	14	24	0	42
	"	FL (2)	Data not available										
	"	NC (2)	Data not available										
Mar. 30	"	GA	19	20	6	21.5	38.4	2	0	19	24	0	45
	"	FL (2)	yes	yes	2	77.4	64.4	Quantities by category unknown					
	"	NC (2)	yes	yes	1	40.1	81.9	Quantities by category unknown					
Feb. 24	SQ	GA	2	18	0	24.7	71.2	0	0	1	19	0	20
	"	TN	0	4	0	6.3	19.2	0	0	0	4	0	4
Mar. 23	"	GA	1	18	1	24.7	69.8	0	0	2	18	0	20
	"	TN	0	4	0	5.7	17.6	0	0	0	4	0	4
Mar. 30	"	GA	1	18	0	24.7	69.9	0	0	1	18	0	19
	"	TN	0	5	1	6.4	19.8	1	0	0	5	0	6

Table 6 continued.....

Notes: 1. RAM routed through Montgomery, AL.
2. These Mallinckrodt RAM are transported through Atlanta by Associated Courier, St. Louis, MO, tractor trailer to states indicated.

Table 7

Skycab Trip Statement for March 28, 1980

Itinerary	Number
Birmingham, AL	21
Montgomery, AL	21
Orlando, FL	59
Atlanta, GA	28
Charlotte, NC	56
TN	22
Richmond, VA	14
	221 Total

Note:
1. Atlanta RAM (28 pieces) was received by Purolator Courier, Atlanta on March 29, 1980 and included seven pieces destined for TN.
2. Orlando, Florida (MCO RAM) was loaded onto Associated Courier at Purolator terminal Atlanta, Georgia by Skycab drivers.
3. It is unknown if Skycab delivered remaining RAM or if another company made some deliveries.
4. The RAM for Charlotte and Richmond would have been delivered before arriving in Atlanta, GA.

Table 8

New England Nuclear RAM Delivered to Purolator Terminal, Atlanta, Georgia on December 2, 1979*

Number of Pieces	Total TI	Isotopes	Category LTD	I	II	III
97	109.6	Mo-99				X
		Ga-67				X
		Ga-67			X	
		Co-57			X	
		Cr-51			X	
		Fe-59			X	
		P-32			X	
		Xe-133			X	
		Xe-133		X		
		I-125		X		
		S-35		X		
		Tl-201		X		
		C-14	X			

*As indicated in Table 5, Mallinckrodt and Squibb RAM are mostly Mo-99 and I-131.

Table 9

Packages Listed on Freight Bill/Bill of Ladings Marked "NON RAM" Distributed by Purolator Courier, Atlanta, from New England Nuclear (NEN), Mallinckrodt (M) and Squibb (SQ) on December 16, 1979

Source	Destination	Quantity
NEN	AL	7
"	GA	21
"	FL	4
M	GA	3
SQ	AL	6
"	GA	3
"	FL	1
"	TN	2 *

*Information on package: T4 CLASP RIA
1 BL (100 ml I-125) T4 Reagent
<3.96 uci/BTL

Table 10

Exposure Rates from Mo-99 Generator Packages
as Function of Geometrical Configuration

No. of packages	Configuration	Exposure rate at given distance, mR/hr 0'	3'	6'	9'	12'	15'	18'
	Squibb, 2.1 ±0.1 TI each, 12"x12"x12"							
1	-	50	2.0	0.55	0.26	0.16	0.11	-
3	side by side	73	5.1	1.7	0.78	0.46	0.30	-
4		72	7.9	2.3	1.1	0.57	0.38	-
5		84	8.8	2.6	1.3	0.76	0.47	-
6		73	9.6	3.3	1.5	0.92	0.61	
7		88	9.6*	3.4	2.7*	1.1	0.66	0.47
8		73	11.4	4.1	2.0	1.2	0.77	0.55
2	1 x 2 high	48	3.3	1.1	0.46	0.28	0.19	
4	2 x 2 high	54	7.5	2.1	1.1	0.56	0.37	
6	3 x 2 high	77	9.6	3.1	1.5	0.87	0.60	
2	1 behind other	46	2.0	0.56	0.30	0.16	0.11	
8	4 behind 4	80	8.4	2.6	1.2	0.66	0.46	0.36
	New England Nuclear, 2.1 ±0.1 TI each, 14.5" 14.5"x15" high							
1		43	1.8	0.54	0.25	0.15	0.10	
3	side by side	60	5.5	1.9	1.0	0.61	0.48	0.35
5		66	8.0	2.8	1.4	0.87	0.62	0.45
6	3 x 2 high	73	9.5	3.6	1.8	1.1	0.73	0.49
8	4 x 2 high	78	13.4	4.7	2.1	1.2	0.76	0.51
10	5 x 2 high	88	14.0	5.4	3.6	1.6	1.0	0.71
9	3 x 3 high	88	14.5	4.8	2.3	1.3	0.86	0.58
10	5 behind 5	73	9.5	4.0	1.8	1.0	0.64	0.41
	Mallinckrodt, 0.9 TI, 16"x16"x17" high							
1		16.5	0.80	0.25	0.11	0.07		

Notes: 1. All measurements were performed at center of configurations.

Table 10 continued

2. All RAM were stacked on wooden cart 31" above concrete floor.
3. All TI values were measured; values on labels were as follows:
   Squibb: 5.2 and 6.2 TI
   NEN: 4.0 TI
   Mallinckrodt: 2.3 TI
4. Two values marked with asterisk were apparently misread and were omitted from data analysis.

Table 11

Exposure Rates from Mo-99 Generator Packages as Function of Inverse Square of Distance

No. of packages	Configuration	Exposure rate, mR/hr per TI, as function of distance^{-2}, ft^{-2} 2.0	0.073	0.022	0.0106	0.0062	0.0041	0.0029
	Squibb, 2.1 ±0.1 TI each, 12"x12"x12"							
1		24	0.95	0.26	0.124	0.076	0.052	-
3	side by side	11.6	0.85	0.27	0.124	0.073	0.048	-
4		8.6	0.94	0.27	0.131	0.068	0.045	-
5		8.0	0.84	0.25	0.124	0.072	0.045	-
6		5.8	0.76	0.26	0.119	0.073	0.048	-
7		6.0	-	0.23	-	0.074	0.045	0.032
8		4.0	0.68	0.24	0.119	0.071	0.045	0.033
2	1 x 2 high	11.0	0.79	0.26	0.109	0.067	0.045	-
4	2 x 2 high	6.0	0.89	0.25	0.131	0.067	0.044	-
6	3 x 2 high	6.0	0.76	0.25	0.119	0.069	0.048	-
	mean:		0.82	0.25	0.122	0.071	0.047	0.032
	Std. Dev.:		0.09	0.01	0.007	0.003	0.003	0.001
	New England Nuclear, 2.1 ±0.1 TI each, 14.5" x 14.5" x15" high							
		1.56	0.069	0.022	0.0104	0.0061	0.0040	0.0028
1		20.5	0.86	0.26	0.119	0.071	0.048	-
3	side by side	9.5	0.87	0.30	0.159	0.097	0.076	0.056
5		6.0	0.76	0.27	0.133	0.083	0.059	0.042
6	3 x 2 high	5.8	0.75	0.28	0.143	0.087	0.058	0.039
8	4 x 2 high	4.6	0.80	0.28	0.125	0.071	0.045	0.030
10	5 x 2 high	4.2	0.67	0.26	0.171	0.076	0.048	0.034
9	3 x 3 high	7.0	0.90	0.25	0.122	0.069	0.046	0.031
	mean:		0.78	0.27	0.139	0.080	0.054	0.039
	Std. Dev.:		0.07	0.02	0.020	0.010	0.011	0.010

Table 11 continued

Mallinckrodt, 0.9 TI, 16"x16"x17" high

	1.31	0.066	0.021	0.0102	0.0060
1	18	0.89	0.28	0.122	0.078

Notes: 1. Distance includes one-half of package width plus 2.5" detector radius; actual distance to center of nearest source is greater than indicated for even number of packages.

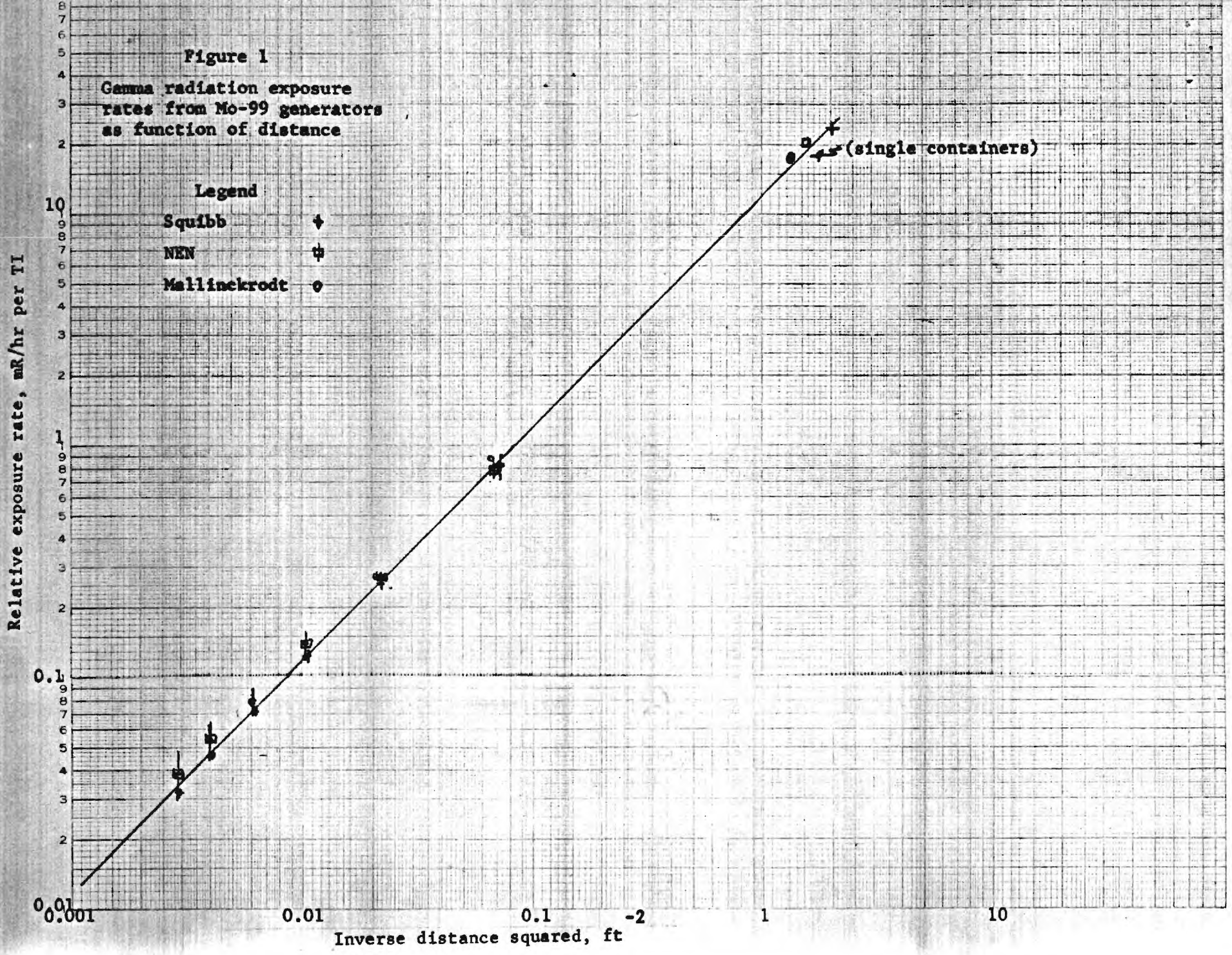
Table 12

Exposure Rates from Double Rows of Mo-99 Generator Packages as Function of Inverse Square of Distance

No. of pkgs.	Configuration	Exposure rate, mR/hr per TI, in front, as function of distance^{-2}, ft^{-2}						
		2.0	0.073	0.022	0.0106	-0.0062	0.0041	0.0029
	Squibb, 2.1 0.1 TI each, 12" x 12"x12"							
2	1 behind other	22	0.95	0.27	0.143	0.076	0.052	
ratio relative to Table 11 mean:			1.15	1.08	1.17	1.08	1.11	
8	4 behind 4	9.5	1.0	0.31	0.143	0.078	0.055	0.043
ratio relative to Table 11 mean:			1.22	1.24	1.17	1.10	1.17	1.13
	New England Nuclear, 2.1 0.1 TI each, 14.5" x 14.5" x 15" high							
		1.56	0.069	0.022	0.0104	0.0061	0.0040	0.0028
10	5 behind 5	7.0	0.90	0.38	0.171	0.095	0.061	0.039
ratio relative to Table 11 mean:			1.15	1.41	1.23	1.19	1.13	1.00

Figure 1

Gamma radiation exposure rates from Mo-99 generators as function of distance



APPENDIX A: OBSERVATIONS

1. On February 13, at Purolator terminal, two RAM packages containing Mo-99 and I-131 were located on the floor outside the dispatcher's window where personnel speak to the dispatcher. This problem was discussed with the supervisor who immediately had a workman move the RAM to the designated RAM holding area. RAM was originally destined for Birmingham, AL; however, flight from St. Louis, MO arrived late and RAM missed the Birmingham express vehicle. RAM was subsequently returned to Mallinckrodt by Associated Courier.

2. Purolator is now auditing RAM TI's to assure that the TI per vehicle does not exceed 50. This requires the company to run two vans on the same route when the TI exceeds 50. However, the actual TI reading for Mo-99 generators are approximately one-half the TI on shipping papers and package labels. There is a delay of 2 days between the time the Mo-99 is prepared by the manufacturer and transported by Purolator. It had been noted earlier, that a Squibb Mo-99 generator with 1.7 curies would have a recorded TI of 2.5; however, now the TI is listed as 5.2. More recently, the boxes are slightly larger but weigh less.

3. Skycab is obtaining additional drivers to move RAM from the Atlanta area to various destinations. Skycab is no longer using Purolator to deliver RAM to Alabama, the Florida pan-handle and parts of Tennessee. It was noted on March 29 that Associated Courier took the Squibb RAM destined for Orlando, Florida. The Skycab itinerary for the weekend of March 28, Table 7, indicates 3 more RAM destinations beyond Atlanta, Georgia. It was further noted that Skycab is no longer delivering RAM to Purolator, Atlanta, on Thursdays, which usually consisted of 50 TI Mo-99 generators.

4. On March 19, Georgia EPD-DNR staff responded to a call for assistance from UPS, Atlanta. A box marked "Electronic Parts" was in the Company lost and found office. The shipment consisted of approximately 40 small boxes that contained Co-60 sources 0.125 uci each, in tubular glass containers that are used for ionization sources. Readings on the surface of each box was 0.1 mR/hr. The smear showed small amount of Co-60 (see in table 5. UPS was trying to determine shipper and destination. Approximately 10 containers inside box were broken. The material was returned to Microwave Associates, Boston, MA.

5. On March 23, at Purolator terminal an Amersham package, Fe-59, yellow 2 labels, 0.1 mCi, bill #T7575 to Medical College of Georgia had Profit By Air telephone label over one of the yellow 2 labels. This recurring problem had been discussed with a representative of Profit By Air on February 13. It had been noted that Profit By Air envelopes etc., are placed over some RAM package labels. A copy of our report was given to Profit By Air.

6. On March 29 at 1645 hours, readings were taken at locations where film was stored at the Purolator terminal; additional measurements were taken on March 30 at 1100 hours. The readings for March 29 and 30 (in parenthesis)are shown below. Between the two sets of measurements, RAM had been broken down by routes, and NEN RAM had been added. Although the readings in most cases were low, doses are accumulated because of the long storage time in the vicinity of RAM over the weekend. This was discussed with supervisor. Company may have to consolidate film at an isolated end of terminal.

Dynacolor Film (north west end of terminal)

0.15 mR/hr - 28 feet from Squibb RAM
(0.20 mR/hr)

Kodac Film (north center of terminal)

0.21
(0.5)

Eastman Film (south center of terminal)

0.17 - 34 feet from Mallinckrodt RAM
(1.30) Four RAM boxes with 6.7 TI nearby.

GEORGIA INSTITUTE OF TECHNOLOGY

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MEMORANDUM

TO: Dr. Wayne Schumann, Director Attn: Mr. Willard Ingram
Radiological-Occupational Health Unit, Georgia DHR

FROM: Dr. Bernd Kahn, Director
Environmental Resources Center

DATE: August 7, 1980

SUBJ: Seventh Quarterly Report of Progress (April 1 - July 31, 1980) of Extended State Transportation Surveillance Program - Radioactive Materials - under agreement between Georgia Department of Human Resources and Georgia Institute of Technology

Monitoring of RAM packages and of vehicles transporting RAM continued this quarter, as well as determining the radiation exposures in persons handling RAM at terminals and in the cabs of vehicles. Further data on the magnitude of RAM shipments in Georgia were also collected.

The list of monitored RAM in transit is given in Table 1. Problems with these shipments, including violations, are listed in the "remarks" column, and in Appendix A.

The exposure rates of workers with RAM, including drivers of RAM vehicles and handlers at terminals, that were measured with TLD's for 3-month periods are summarized in Tables 2a to 2i. Typical background exposure rates for 3-month periods are 13 to 26 mR at Atlanta, as determined during the previous year. Some elevated levels are shown in Tables 2e, 2h, and 2i for this quarter. As a check on these values, because there is no assurance that the dosimeters are used appropriately, dosimeters placed at drivers' seats in vehicles and on walls at terminals were also read, with the results shown in Tables 3 to 5. Some elevated exposures were observed at drivers' seats (see Tables 3 and 4) and at terminals (Table 5) during this quarter. These values may exceed exposures to persons because the TLD's were exposed to RAM while no person was nearby, but are indications of high exposure rates in the area.

Vehicle monitoring for RAM is summarized in Tables 6 and 7, and violations are listed in the footnotes to Table 6. Results of analyzing surface smears of RAM vehicles that showed contamination are given in Table 7. All of these are at very low levels. All other smears of packages

and vehicles showed no contamination, either of gross activity or specific radionuclides as determined by gamma-ray spectrometry.

Information obtained from records concerning shipments of RAM through Georgia is compiled in Tables 9 through 22. The RAM listed in Table 16 were reported by NRC inspectors; all other RAM were recorded by the respective carriers.

Several significant changes have occurred in the distribution systems for radiopharmaceutical RAM, which before this quarter had been mainly distributed by Purolator Courier from its Atlanta terminal:

1. New England Nuclear has established a branch office in Atlanta, beginning May 19, 1980. Five shipments per week are received, primarily of Ga-67 and Xe-133, by Airborne Charter Express. A tractor trailer delivers RAM, mainly Mo-99 every Sunday. Outbound RAM from this office is carried by Purolator.
2. Air Lift International ceased operation at Atlanta effective April 15, 1980. Apparently Flying Tiger carries RAM formerly carried by AI.
3. Sagen Air (formerly Golden Eagle) carries RAM produced by New England Nuclear that has been carried by tractor trailer to Atlanta from here to New Orleans, LA, Jackson, MS, and Nashville, TN.
4. RAM produced by Squibb which are carried to Atlanta by Skycab truck every Saturday are transferred in part to vans operated by a local contractor for distribution in Atlanta, to Columbus, GA, and to Alabama (See Tables 10 - 12).

It is noted that New England Nuclear, Skycab, and Associated Courier now operate under an exemption (DOT E-8308) that limits a vehicle to 50 TI except that packages containing Mo-99 (which constitute most of the TI under usual circumstances) shall not be included in the total. The driver is limited to a whole body dose of 1.25 rem per calendar quarter.

Purolator Courier is still auditing its TI totals so as not to exceed 50 TI per vehicle. This pertains at present only to the Macon route and transfer of RAM from the New England Nuclear local office to the Purolator terminal, both on Sunday.

On May 17, 1980, a Federal Highway Administration, US DOT, inspector monitored operations at the Purolator Courier terminal in Atlanta.

During the next quarter, the activities described above will be concluded. A major change is anticipated in handling RAM by passenger airlines when the new terminal is placed into operation on September 21, 1980, hence area radiation measurements at the existing terminal will be ended for this study period early in september. Efforts will be made to monitor and obtain more information on radiography sources.

Table 1

Monitored RAM Packages

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category Ltd	I	II	III	Remarks*
April 24 Kenworthy AF	0.1	Cs-137	0.4			1		RAM in special form. Ohmart Corp. Cincinnati, OH to Mansanto Co. Decatur, AL (0.2)
April 26 Purolator	1.1	Mo-99	3.6				1	Squibb freight bill to Athens General Hospital was dated April 18. Box was marked "Return to sender-Refused Shipment" Skycab took package on April 26. (0.5)
May 14 Federal Express	0.010 0.050	Cs-137 Am-241/Be	0.1			1		RAM in special form. Brainard Kilman Drill Co Tucker, GA to Coral Gables Fl. Package authorization and type were not visible. (0.2)
	0.0004	U-235	-		1			168 grams DOT 6M Type B container from Oak Ridge, TN to SRP Aiken, SC. Overnite Transportation Co. refused shipment. RAM held pending resolution.
	0.0045	Ra-226	0.5			1		Seaman Nuclear Corp. Atlanta, GA to Pittsburgh, PA. (Density gauge). Shipper failed to attach package seal after opening box to include papers. Federal Express applied tape for security. (0.5).
May 14 Flying Tiger	228	Ir-192	1.3				1	Type B RAM in special form Technical operations Burlington, MA to Peru. Nails for package seal. Shipping papers were not available. (1.8)
May 14 Delta Cargo	0.49 0.002	Mo-99 I-131	1.0				1	Skycab overpack Newark Airport to Atlanta. Items loose inside box. Staples used for package seal; some staples were loose on top and bottom of overpack (0.8)
	0.0018	I-123	0.1			1		Medi-Physics Overpack. Newark Airport to Brunswick, GA. (0.1)
	0.010 0.020	I-123 Ga-67	0.6			1		Medi-Physics Overpack Newark Airport to Atlanta (0.3)
	0.0048 0.010	I-123 Xe-133	0.3			1		Medi-Physics Overpack Newark to Atlanta (0.1)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Ltd	I	II	III	Remarks*
	0.002	P-32	0.1			1		NEN, Boston, MA to Augusta GA. Item loose inside box. Bottom and side of box were wet. Wipes taken showed no contamination. Package contained dry ice. (0.1)
May 17 Purolator	0.010	I-125	0.1			1		Amersham (Profit By Air) Chicago, IL to Augusta, GA. Item was loose inside package (0.1)
	0.00077	I-125	0.2			1		Amersham (Profit By Air) Chicago, IL to Ft. Gordon, GA (0.2)
	0.037	I-131	0.7				1	Mallinckrodt overpack arrived in Atlanta on Eastern AB 007 STL 1208-1436, FLT 271/13 as 1 of 4 pieces; however, packages inside were destined for NY. Overpack labels were corrected to show all isotopes and TI. The box was resealed. (0.9) Associated Courier picked up RAM on May 17, 1980 for return to manufacturer.
	(The following packages were found inside subject overpack)							
	1 mCi	Se-75	0.1					
	2 mCi	I-131	0.2					
	12 mCi	I-131	0.3					
	10 mCi	P-32	0.2					
	12 mCi	I-131	0.3					
	unknown	unknown	-	(Ltd)				
June 11 Flying Tiger	0.0004	Depleted Uranium	0.2			1		Lockheed GA. Co. From Marietta, GA to Montreal, Canada (0.1)
	0.080	Po-210	-		4			Minnesota 3 M. Staples used for package seal. From New Brighton, MN to San Juan, Puerto Rico.
	108	Ir-192	1.4				1	NRC USA/9032/B - Type B RAM in special form. Technical Operations, Burlington, MA to Colombia (0.1)
June 11 Delta Cargo	0.046	Ga- 67 Xe-133	0.4			1		Diagnostic Isotopes overpack. Bloomfield, NJ to Atlanta (0.2)
June 13 NEN	2,500	Xe-133	0.1			1		NEN (0.1)
	2,500	Xe-133	0.1			1		NEN (0.1)
June 13 Airborne Freight	0.010	I-125	0.1			1		Amersham, Chicago, IL to Gainesville, FL. RAM was being held pending proper shipping certificate. Item was loose inside (0.1)
June 16 Flying Tiger	30,000	H-3	-		1			Type USA 5552/B RAM as a gas (3.13 grams) From Oak Ridge, TN to Bucks, England.

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Ltd	I	II	III	Remarks*
June 19 Flying Tiger	3,460	Ir-192	0.3			1		USA DOT WC type B container from Oak Ridge, TN to Industrial Nuclear Co., Foster City, CA (0.4)
	0.029	Depleted Uranium	0.2			1		Lockheed Georgia Co.,Marietta GA to Eastern Airlines, Miami FL. RAM was being held pending disposition. TI was not listed on package labels, labels were not on opposite ends of box, and LSA was not listed on air bill.(0.2)
June 19 Purolator	0.051	I-131	1.5				1	Mallinckrodt, St. Louis, MO to Atlanta, GA (1.5)
	0.001	I-131	0.1			1		Mallinckrodt, St. Louis, MO to Atlanta, GA (0.3)
June 20 Flying Tiger	0.050	Xe-133	-		1			Medi-Physics Overpack, Chicago, IL to Huntsville, TX.
June 20 Kenworthy AF	0.030 0.10 0.020 7 uCi	I-125 H-3 S-35 Co-57	0.4			1		Amersham (Profit By Air) Overpack Chicago, IL to Atlanta, GA Staples used as seals. (0.1
	0.0012	H-3	-		1			Amersham (Profit By Air) Overpack. Chicago, IL to Dallas/Ft. Worth, TX. Staples used as seals.
	308 uCi	I-125	0.2			1		Amersham (Profit By Air) Chicago, IL to Memphis, TN. Staples used as seals. (0.1)
	0.030 0.0052	I-125 H-3	0.2			1		Amersham (Profit By Air) Overpack-Chicago, IL to Dallas/Ft. Worth, TX. Staples used as seals. (0.1)
June 21 Purolator	253	Mo-99	3			1		Squibb bill #31284I to Middle Georgia Hospital, Macon, GA was dated June 16, 1980. Package was consigned to Mediray Inc., Tuckahoe, NY. Package was returned to Purolator to be held for return by Skycab. Paperwork and labels showed Y II, 253 curies with TI of 3; however TI noted was only 0.5. New labels had been placed over original labels.
June 22	0.050	Cr-51	0.2			1		Amersham (Profit By Air)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Ltd	I	II	III	Remarks*
Profit By Air	0.0115	H-3						Overpack From Chicago, IL to Dallas Ft. Worth, TX (0.2)
June 22 Purolator	0.050 (total)	Xe-133 I-123	0.4			1		Medi Physics Overpack From Newark Airport to Atlanta, Ga. (0.1)
June 23 Purolator	0.006	Ga-67	0.1			1		NEN From Atlanta, GA to Concord, NC (0.1)
	0.002	Tl-201	-		1			NEN Georgia

*Type A package unless otherwise specified.
Origin and destination listed unless shipments were exclusively in GA.
Measured TI shown in parenthesis.
Pertinent observation noted.

Table 2a

Federal Express Personnel Radiation Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	Exposure rate, mR/period 3/20/80 to 6/23/80
1 A	Night Ramp Agent	19	NR*

*NR - not recovered

Table 2b

Delta Cargo Terminal Personnel Radiation Monitoring with TLDs

TLD#	Shift	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80
1	(B)	Clerk (office on 2nd floor) (Control)	25 (21)**	21
3	(C)	CSA Add-to/Spec Ser and Inbound	14	NR
4	(C)	Gate Agent, Main Terminal	NR*	NR
5	(C)	Unloading Aircraft, Main Term.	NR	NR
6	(A)	SCSA	56 (58)	-
6A	(A)	SCSA Spec Ser Agent	14	14
7	(C)	CSA Add-to	16	15
8	(A)	CSA Sorter	15	15
9	(C)	Ticket Counter, Main Terminal	25 (21)	NR
9A	(C)	SCSA Spec Ser Agent	16	15
10	(D)	SCSA Floor	16	17
11	(D)	SCSA Spec Ser Agent	20	17
12A	(D)	SCSA Add-to/outbound	NR	NR
13	(D)	SCSA Sorting Area	NR	25 (27)
16	(C)	Spec Ser Agent	16	18
17	(C)	Spec Ser Agent	17	16
18	(D)	SCSA	NR	25 (27)
19	(D)	SCSA	18	15
20	(E)	Gate Agent, Main Terminal	NR	NR
21	(C)	Senior Ser Agent	NR	30 (27)

Shift: (A) 2315-0700 (B) 0800-1700 (C) 1500-2330 (D) 0700-1515

*NR - not recovered

**-number of weeks other than shown in heading

Table 2c

Eastern Cargo Terminal Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80
1	Ramp Service (1620-0020)	16	16
2	Ramp Service (1620-0020)	14	NR*
3	Ramp Service (0010-0810)	17	12
4	Supervisor (0800-1700)	21	17
5	R/S Front door and belt man (1620-0020)	22	20
6	Lead Ramp Service (0010-0810)	15	NR
7	Ramp Ser Air Express (0900-1730)	19	10
8	Ramp Ser Air Express (0110-0910)	28(21)**	14

* NR-not recovered
** Number of weeks other than shown in heading

Table 2d

Profit By Air Terminal Personnel Radiation Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/20/80
1	Driver, Atlanta area	20	15
2	Driver, Atlanta area	18	14

Table 2e

Purolator Courier Personnel Radiation Monitoring with TLDs

TLD #	Position (Route)	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80
1	Office Secretary (Control)	14	17
3	Driver (028)	30 (21)+	24
4	Driver (039)	65	42
6	Driver (014)	36	20
7	Weekend Dispatcher (supervisor)	54	28
10	Driver (086)	NR*	70 (67)
11	Driver (037 & 086)	14 (4)	30
12	Driver and Terminal Sorter	52	81
14	Supervisor	19	17
15	Terminal Sorter	NR	-
18B	Driver (002)	22	17
19A	Driver (305)	17	16
36A	Driver/Supervisor	19	16
39	Driver (035)	30 (21)	19
43	Driver (008)	NR	
45	Driver (100)	NR	80 (27)
46	Driver (400)	76	NR
47A	Driver (045)	21	18
48	Driver (001)	14	15
49	Driver (016 & 004)	23	22
53	Driver (103)	NR	50 (27)
56	Sorter, weekends	NR	220 (42)
60	Driver (100 & 108)	NR	NR
63	Driver (011)	19	15
67	Driver (024)	40	33

Table 2e continued.....

68	Driver (051)	NR	31 (27)
70	Sorter, week nights	74	NR
74	Air Express	NR	NR
75	Driver (400)	NR	NR
76	Driver (005)	22	18
77	Driver (006)	20	19
83	Supervisor, weekend	28	NR
84	Sorter, week nights	22	17
89	Driver (001)	21	18
90	Driver (080)	NR	NR
93	Driver (015)	NR	NR
95	Driver (022)	NR	NR
96	Driver (080)	34	NR
99	Driver (008)	NR	NR
100	Sorter, weekend	53 (4)	NR
103	Driver (008)	-	NR
105	Driver (008)		7 (8)

* NR-not recovered
\+ No. of weeks other than shown in heading.

Table 2f

Associated Courier Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/29/80	3/29/80 to 6/21/80
52	Driver	650 (21)+	NR*
73	Driver	900 (22)	NR
104	Driver	-	NR

Note: 1. Route-St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC, to West Palm Beach, FL.

2. Drivers sometimes switch to a Texas route from St. Louis, MO.

*NR - not recovered
+number of weeks other than shown in heading

Table 2g

New England Nuclear Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/16/79 to 3/30/80	3/30/80 to 6/22/80
1	Driver	1100 (22)+	NR*
4	Driver	850 (22)	NR
5	Driver	NR	NR
6	Driver	NR	NR

Notes: 1. Route - Billerica, MA; Atlanta, GA; Nashville, TN; Oak Ridge, TN; to Billerica, MA.

2. Drivers alternate on weekend trips.

*NR - not recovered.
+ number of weeks other than shown in heading.

Table 2h

Skycab Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/15/79 to 3/22/79	Exposure rate, mR/period 3/22/79 to 6/21/80
50	Driver	NR*	2300 +
59	Driver	1300	NR

Note: 1. Route - New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA; to Orlando, FL. Effective March 29, 1980, Orlando, FL route was dropped. Route now terminates in TN.

* NR - not recovered.

\+ Exposed for 34 weeks. In addition, another TLD (#50) issued July 28, 1979 was recovered on June 21, 1980 and had a reading of 1044 mR. However, TLD was not on person but in a box beside driver's seat.

Table 2i

Contractor for Skycab (Atlanta, Georgia): Personnel Radiation Monitoring with TLDs

TLD #	Position (Route)	Exposure rate, mR/period 4/26/80 to 4/28/80	5/2/80 to 6/20/80
1a	Driver (wallet)	29	120
1b	Driver (Shirt pocket)	24	-
2	Driver	-	NR*
3	Driver	30	120
4	Driver	48	NR

* NR-not recovered

Note: 1. Route-East Point, to Columbus, GA and intermediate stops at hospitals enroute to Montgomery and Birmingham, Ala. On April 26, 1980, three drivers were in vehicle to learn route. Drivers are suppose to alternate for weekend runs.

Driver #1 also transports RAM to hospitals in Atlanta area on Saturday evenings.

Table 3

Vehicle Radiation Monitoring with TLDs

TLD #	Vehicle #	Route ID	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80
	Purolator			
20	15180	(015)	NR*	NR
22	15181	(028)	22	20
23	15170	(039)	24	NR
24	15171	(015)	NR	NR
25	15147	(a)	NR	NR
26	15201	(086, 039)	30	Lost
27	15207	(014)	16	18
28	15194	(305)	39 (25)**	NR
29A	15182	(086)	36 (21)	18
30	16144	(028)	NR	NR
32	56078	(b)	NR	NR
33	37064	(018)	NR	18
34	15165	(024, 037, 080, 039)	NR	NR
35A	15174	(081)	22	20
38	16111	(a)	NR	NR
40	15149	(035)	34	28
44	15145	(008)	NR	NR
54	15203	(080)	30	29
57	15208	(100)	NR	NR
61	16725	(400)	NR	NR
62	15205	(008)	85 (38)	40
64	15178	(011)	NR	NR
65	912	(039)	22	18
66	15209	(081)	45	NR
69	15186	(051)	19	NR
72	15192	(081)	21	19

Table 3

81	15218	(100)	NR	NR
85	15214	(028)	80	29
86	16724	(400)	580 (26)	200
91	15289	(080)	NR	NR
92	15227	(305)	14	13
94	15223	(015)	47	NR
97	15212	(080)	43	NR
98	15224	(028)	29	23
101	15231	(028)	-	NR
	Associated Courier			
87	P83094	(c)	580 (21)	330
	New England Nuclear			
3	55	(d)	410	112
	Skycab			
88	XRC92U	(e)	1400	NR
	Skycab			
3	XRC92U	(e)	-	870 (f)

Notes: (a) Atlanta to Birmingham, AL
(b) Atlanta To SC
(c) St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC to West Palm Beach, FL
(d) Billerica, MA; Atlanta, GA; Nashville and Oak Ridge, TN;
(e) New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA; to Orlando, FL
(f) TLD Skycab 3 was issued on October 25, 1979 and was recovered on June 21, 1980 (34 weeks). However, van was subsequently sold and TLD was carried in other vehicles. Routes and dates associated with subject reading are unknown.

*NR - not recovered.
** Number of weeks other than shown in heading

Table 4

Vehicle Radiation Monitoring with TLD's:
Contractor for Skycab (Atlanta, GA)

TLD #	Vehicle # Route *	Exposure rate, mR/period 4/26/80 to 4/28/80	5/2/80 to 6/20/80
5	TEA 529 (behind driver's seat)	36	360
6	TEA 529 (behind passenger's seat)	-	510
7	TEA 529 (behind rear seat)	250	1560

* East Point, Georgia to Columbus, Georgia with intermediate stops at hospitals to Montgomery and Birmingham, Alabama. Vehicle departs every Saturday night after transferring RAM from Skycab vehicle which started at East Brunswick, NJ.

Table 5

Site Radiation Monitoring With TLD's

TLD Location		Quarterly Exposure, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80	2/13/80 to 5/15/80
Terminal A, Airborne				
1C *	Office, under desk	---	15	17
2	RAM Area, south wall	---	33	39
Terminal B, Airlift Intl.				
1C	Office, on wall	M+	34	30
2C	Breakroom, on wall	M	M	27
3	Left side RAM area, on wall	51	39	44
4	Center RAM area on wall	M	M	40
5	Right side RAM area, on wall	M	46	24
6	Pillar south/east side outbound area	24	20	20
7	Wall, south side Outbound area	45	43	38
8	Pillar, west end Outbound area	M	16	21
9	Pillar, west end Outbound Area	M	18	26
Terminal C, Delta Cargo Terminal				
1C	North wall	32	29	32
2C	East wall	31	30	30
3	Inbound RAM (Hazardous Holding area)	46	38	47
4	Outbound RAM	19	M	21
5	East wall between doors 6 & 7	26	31	23
6	Pillar, east side opposite doors 6 & 7	32	27	25
Terminal D, Eastern Cargo Terminal				
1	RAM Area, Terminating Bins 3 & 4	66	41	89
2	RAM Area, Terminating Bins 1 & 2	54	52	71
3C	Steel pillar, SE end of terminal	16	15	16
4	RAM area, Outbound	22	26	14

5	RAM Area, Inbound on steel pillar	15	14	15
6	RAM Area, Terminating Bins 2 & 3	53	41	71
7	RAM Area, Terminating Bins 4 & 5	52	31	45
8	Left side of pickup door #1	30	22	30
Terminal E, Emery Air Freight				
1C	Office, under desk	M	16	15
2	RAM Area on post	32	14	30
Terminal F, Federal Express				
1C	Office	M	22 (a)	23
2	End of roller conveyor, east terminal	23	21	30
3	Bin pkg holding area outside office		20	M
Terminal G, Flying Tiger				
1C	Office	22	22	23
2	Wall left corner RAM area	36	98	60
3	On pillar center of RAM area	34	88	260
Terminal H, Profit by Air				
1C	Office	M	17	M
2	RAM area, east wall	19	18	17
3	RAM area, post to left of east wall	20	20	20
Terminal I, Purolator				
1C	Breakroom on water fountain	M	15	16
2	West wall, between door 2 & 3	34	54	80
3	By dispatcher's window inside cabinets	320	290	180
4	North wall, left side men's latrine	72	68	340
5	South wall, between doors 4 & 5	270	200	280
6	South wall, between doors 7 & 8	M	450	530
7	North wall, by door 16	92	62	69
8	South wall, between doors 1 & 2	57	35	52

9	East side between doors A & B	690	560	1000
10	East side between doors B & C	560	440	760

* Denotes Control TLD
\+ M: Missing

Notes: a. F (1C) TLD was attached to file cabinet in office which was subsequently moved out in the terminal area in a fenced storage area.
b. Terminal B, Airlift International, in Atlanta, Georgia ceased operations effective May 15, 1980.

Table 6

Vehicle Monitoring Results

ate	Location	Vehicle	Route	Radiation Levels (mrem/hr) Cab	Surface	Six Ft.	Transport Index	Excessive Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
pril 1980												
5	Note 1	P83094	A	0.4 0.9 (sleeper)	70	10	185.6	Table 8	Rear	yes	yes	
5		XRC92U	B	0.3 0.8 (Passenger)	30	unknown	unknown	none	Rear	(2)	yes	(3)
5	East Point, GA	TEA529	C	3.2 3.5 (Passenger) 11.0 (rear)	80	7	143.0	unknown	Rear	(2)	yes	(3)
7		NEN55	D	(4)	(4)	(4)	35.4	none on steering wheel, rear bed	Front	yes unknown	yes	(3)
7		15213	080	0.8	14	1.7	29.1	unknown	Middle Rear	yes	(5)	(5)
7		15223	028	0.6	55	4.5	43	unknown	Rear	yes	yes	
7		16724	400	0.4	30	3	47.9	unknown	Rear	yes	yes	
7		16738	100	0.8	14	(4)	27.1	unknown	Rear	yes	yes	
7		15180	015	0.7	35	2.5	32.2	unknown	Rear	yes	yes	
7		15205	008	0.8	18	1.9	14.5	unknown	Rear	yes	yes	
ay												
7		P83094	A	0.4 0.6 (sleeper)	80	12	227.1	none	Rear	yes	yes	(6)
une												
9	Eastern Cargo	15149	035	0.3	unknown	unknown	2.6	unknown	Front and Rear	yes	yes	

21		P83094	A	0.2	35	7	215.1	Table 8	Rear	yes	yes	(7)
21	Hapeville, GA	XTM792	B	1.2	54	unknown	272.6	Table 8	Front to Middle	(2)	yes	(3)
21	Hapeville, GA	TEA529	C	3.5	70	5.2	135.5	unknown	Rear	(2)	yes	(3)
21	Hapeville, GA	WJ1484	E	0.9	26	1.3	16.0	none	Rear	yes	yes	
22	NEN Atlanta	NEN55	F	0.2 0.4	15 (sleeper)	2.1	192.3	Table 8	Middle	yes	yes	
22		15201	080	0.4	10	1.2	13.4	unkonwn	Rear	yes	yes	
22		15234	001	0.2	3.2	0.3	2.5	unknown	Rear	yes	yes	
22		15205	008	0.3	15	1.3	11.0	unknown	Rear	yes	yes	
22		15235	015	0.4	15	1.5	31.6	unknown	Rear	yes	yes	
22		16724	400	0.6	20	1.7	45.6	unknown	Middle Rear	yes	yes	(8)
22		15168	100	1.1	20	2	27.3	unknown	Rear	yes	yes	(9)
22		15214	028	0.9	16	unknown	43.3	unknown	Rear	yes	yes	
23		15207	015	0.02	0.05	0.03	0.1	unknown	Rear	yes	yes	
23		15225	089	0.02	0.2	0.03	0.2	unknown	Front	unknown	yes	
23		37064	064	0.02	2.6	0.05	0.4	unknown	Rear	(10)	yes	
29	Charlie Brown Airport, Atlanta	NEN55	F	0.12 0.2	12 (sleeper)	2	261.8	Table 8	Middle	yes	yes	(3)

Notes: A-Associated Courier-St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC; Athens and Waycross, GA; to West Palm Beach, FL.
B-Skycab-East Brunswick, NJ; Charlotte, NC; Atlanta, GA and TN.
C-Skycab (Local Contractor)-Atlanta, GA; Columbus, GA; to Montgomery and Birmingham, AL.
D-NEN-Billerica, MA; Alexandria, VA; Charlotte, NC; Atlanta, GA; Nashville, TN; to Oak Ridge, TN; and return to Billerica, MA.
E-Skycab (Local Contractor)-Atlanta Hospitals in Atlanta, GA.

F-NEN (New Route) Billerica, MA; NJ; Alexandria, VA; Charlotte, NC; Atlanta, GA (two locations include Charlie Brown Airport and NEN office) to Orlando, FL; Oak Ridge, TN; and return to Billerica, MA.

1. All locations at Purolator Courier Terminal, Atlanta, GA unless otherwise noted.
2. Driver had only individual freight bills for RAM packages.
3. Company is now operating under exemption DOT E 8308.
4. Readings included contribution from RAM inside building.
5. New driver failed to display placards until advised that placards were required. Reading in cab was 3.0 mR/hr with only 3 1/2 feet separation distance. Driver was advised that RAM was too close to his seat so he repositioned RAM for more distance.
6. Vehicle was also inspected by representative from DOT Federal Highway Administration.
7. Associated Courier is also operating under exemption DOT E 8308, dated May 29, 1980. It was also noted that the trailer has 5000 lbs of steel plating in front and sides of trailer to reduce radiation readings.
8. Alternate driver for route loaded RAM with only 3 feet separation distance. Reading in cab was 1.9 mR/hr. Discussed observations with driver, who repositioned RAM to get separation distance of 7 feet with a cab reading of 0.6 mR/hr.
9. Reading in cab was 1.4 mR/hr with 6 foot separation distance. Discussed observation with driver who replaced a Mo-99 generator, TI of 6.0 with one with a TI of 2.5 in front to reduce reading to 1.1 mR/hr.
10. NEN bill of lading #450658 to Columbia, SC for Ga-67, TI 0.3, Y II did not show label category nor TI.

Table 7

Aircraft Monitoring Results

Sagen Air (formerly Golden Eagle), Manchester, New Hampshire
(Exemption DOT E 7060, Dated January 23, 1980)

1980 Date	Location	Aircraft	Cockpit	Surface	Six Ft	Transport Index	Package Placement	Proper Shipping Documents
June 29	Charlie Brown Airport, Atlanta	N474SA	3.9	45	4	77.4	Center	yes

Remarks:
1. NEN delivers RAM by tractor trailer to aircraft Sunday morning. Operation began in June.
2. Aircraft flies RAM to New Orleans, LA (TI 23.0); Jackson, MS (TI 21.8) to Nashville, TN (TI 32.6) and returns to Manchester, NH empty.
3. Pilot, co-pilot, and aircraft had film badges.
4. Separation distance was 53 inches from pilot to RAM. Pilot stated that company has ordered vinyl lead shield to be installed in aircraft.
5. Personnel were especially helpful and cooperative.
6. Aircraft #N474SA was a Piper Chieftain.
7. No removable contamination noted.

Table 8

Surface Contamination Measured By Smears of Vehicles and RAM Packages

Date, 1980	Area, cm^2	Object Smeared	Radionuclide Level, pCi/100 cm^2			
			Se-75	Mo-99	I-131	Co-57
April 26	2800	Associated Courier Trailer bed	0.13	0.10	< 0.1	-
June 21	5600	Skycab vehicles-rear bed and steering wheel	<0.05	< 0.05	< 0.05	0.07
June 21	7000	Associated Courier vehicle-steering wheel and rear bed	<0.08	0.05	< 0.08	< 0.04
June 22	7000	New England Nuclear vehicle-steering wheel and rear bed	<0.03	0.05	< 0.03	< 0.02
June 29	1850	New England Nuclear vehicle-rear bed	<0.3	< 0.3	< 0.3	0.34

Table 9

Summary of Weekend RAM Shipments Distribution by Purolator Courier, Atlanta, Georgia from New England Nuclear (NEN), Mallinckrodt (M) and Squibb (SQ)

1980 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category Ltd.	I	II	III	Unk.	Totals
April 27	M	GA	15	23	8	25.1	44.2	0	0	18	28	0	46
May 18	M	GA	16	23	6	25.4	46.0	2	0	15	28	0	45
June 22	M	GA	14	23	4	25.9	46.6	0	0	16*	25	0	41
April 27	NEN	AL	0	12	28	12.4	35.9	3	18	4	15	0	40
		GA	0	13	18	15.8	49.1	2	13	3	13	0	31
		FL (1)	-	2	4	3.7	7.1	0	3	1	2	0	6
June 22	NEN	AL	0	13	16	12.7	38.3	2	8	3	16	0	29
		GA	0	12	18	14.4	46.5	4	8	5	13	0	30
		FL (1)	0	2	1	2.7	5.0	0	1	0	2	0	3
April 27	SQ	GA	3	18	2	25.2	66.2	0	0	5	18	0	23
		TN	0	6	1	8.1	25.0	1	0	0	6	0	7
June 22	SQ	GA	1	13	1	15.6	50.9	0	0	1	14	0	15
		TN	0	4	2	5.7	18.0	0	0	2	4	0	6

*Mallinckrodt Mo-99 generator #J 99652 B to Cartersville, GA, activity of 0.25 curie, TI 0.8 had yellow II labels on package; however, bill of lading had a correction changing labels from Y II to Y III.

Note 1: RAM destined to Florida is routed thru Montgomery, AL.

Table 10

Summary of Weekend RAM Shipments Distribution by Local Contractor
for Skycab, East Brunswick, New Jersey

1980 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category Ltd.	I	II	III	Unk.	Totals
April													
26	Squibb	Columbus, GA	0	1	0	1.7	5.2	0	0	0	1	0	1
		Birmingham, AL	0	18	1	28.7	74.1	0	0	1	18	0	19
		Montgomery, AL	2	18	0	21.6	63.7	0	0	1	19	0	20
	TOTALS		2	37	1	52.0	143.0	0	0	2	38	0	40
June													
21	Squibb	Columbus, GA	0	1	0	1.7	5.2	0	0	0	1	0	1
		Birmingham, AL	0	17	1	27.0	70.0	0	0	1	17	0	18
		Montgomery, AL*	2	17	0	19.9	60.3	0	0	2	17	0	19
	TOTALS		2	35	1	48.6	135.5	0	0	3	35	0	38

*RAM includes 5 each Mo-99 generators destined for Marianna, Ft. Walton, Graceville, Panama City, and Chipley, FL.

Table 11

Summary of Weekend RAM Shipments Distribution by Local Contractor in Atlanta, Georgia from Skycab, East Brunswick, New Jersey*

1980 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category Ltd.	I	II	III	Unk.	Totals
June													
21	Squibb	Atlanta, GA											
		Piedmont Hospital	0	1	0	1.7	5.2	0	0	0	1	0	1
		Emory Hospital	0	1	0	2.8	4.2	0	0	0	1	0	1
		Doctors Hospital	0	1	0	0.6	1.9	0	0	0	1	0	1
		Grady Hospital	1	1	0	2.8	4.7	0	0	1	1	0	2
		TOTALS	1	4	0	7.9	16.0	0	0	1	4	0	5

*Different vehicle from distribution shown in Table 7.

Table 12

Summary of Weekend RAM Shipments Distribution by Skycab, East Brunswick, New Jersey to or through Atlanta, Georgia per Freight Bills

1980 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category Ltd.	I	II	III	Unk.	Totals
June													
21	Squibb	Atlanta (Purolator Courier)	1	17	3	21.3	68.9	0	0	3	18	0	21
		Atlanta Skycab (local)	1	4	0	8.0	16.0	0	0	1	4	0	5
		Atlanta Skycab (local)	2	35	1	48.6	135.5	0	0	3	35	0	38
		TN	0	14	0	19.0	47.0	0	0	0	14	0	14
		Atlanta Airport (Piedmont Air Lines to Myrtle Beach, SC)	0	1	0	1.7	5.2	0	0	0	1	0	1
		TOTALS	4	71	4	98.6	272.6	0	0	7	72	0	79

Table 13

Summary of Weekend RAM Shipments Distribution by Sagen Air (formerly Golden Eagle), Manchester, New Hampshire, from Atlanta, Georgia (Per Shipping Certificates)

1980 Date	Source	Destination	TI
June 22	NEN	New Orleans, LA	22.8
		Jackson, MS	21.2
		Nashville, TN	33.2
		Total	77.2
June 29	NEN	New Orleans, LA	23.0
		Jackson, MS	21.8
		Nashville, TN	32.6
		Total	77.4

Table 14

Summary of Weekend RAM Shipments Distribution by NEN, Billerica, MA to or through Atlanta, Georgia (Per Shipping Certificates or Bill of Ladings)

1980 Date	Source	Destination	TI
June 22	NEN	NEN Atlanta Office	8.0
		NEN Atlanta Office (for Purolator Courier)	89.9
		Charlie Brown Airport Atlanta, GA for Sagen Air	77.2
		Orlando, FL (Miami RAM)	28.2
		Orlando, FL (Tampa RAM)	66.3
		Totals	269.6
June 29	NEN	NEN Atlanta, GA Office	10.0
		NEN Atlanta, GA Office (for Purolator Courier)	95.4
		Charlie Brown Airport Atlanta, GA for Sagen Air	77.4
		Orlando, FL (Miami RAM)	12.5
		Orlando, FL (Tampa RAM)	66.5
		Totals	261.8

Table 15

Summary of Weekend RAM Shipments Distribution by Associated Courier, St. Louis, Mo. to or through Atlanta, Georgia per Bill of Lading (Shipping Papers)*

1980 Date	Source	Destination	I-131	Mo-99	Misc.	Activity, curie	TI	Category Ltd.	I	II	III	Unk.	Totals
April													
26	Mallinckrodt	Atlanta, GA (Purolator Courier)	2	23	0	25.2	42.6	0	0	0	25	0	25
		Charlotte, NC	6	42	2	39.2	81.3	0	0	4	46	0	50
		Athens, GA	1	1	1	1.0	1.6	0	0	2	1	0	3
		Waycross, GA	1	1	0	1.0	1.3	0	0	1	1	0	2
		Tampa, FL	2	29	0	47.4	62.2	0	0	1	30	0	31
		Ft Lauderdale, FL	1	18	0	29.1	39.2	0	0	1	18	0	19
		TOTALS	13	114	3	142.9	228.2	0	0	9	121	0	130
May													
17	Mallinckrodt	Atlanta, GA (Purolator Courier)	1	23	5	25.4	43.0	5	0	0	24	0	29
		Charlotte, NC	7	42	8	39.2	74.7	7	0	6	44	0	57
		Athens, GA	1	1	0	1.0	1.3	0	0	1	1	0	2
		Waycross, GA	1	1	1	1.0	1.2	1	0	1	1	0	3
		Tampa, FL	4	31	5	50.8	67.5	5	0	2	33	0	40
		Ft Lauderdale, FL	0	17	7	31.0	39.3	5	0	1	18	0	24
		TOTALS	14	115	26	148.4	227.0	23	0	11	121	0	155

June

21	Mallinckrodt	Atlanta, GA (Purolator Courier)	2	23	0	22.9	43.6	0	0	2	23	0	25
		Charlotte, NC	8	44	1	40.1	81.4	0	0	6	47	0	53
		Athens, GA	1	1	0	1.0	1.4	0	0	1	1	0	2
		Waycross, GA	1	1	0	1.0	1.3	0	0	1	1	0	2
		Tampa, FL	2	27	0	47.5	50.7	0	0	0	29	0	29
		Ft Lauderdale, FL	1	17	2	29.2	36.7	0	0	3	17	0	20
		TOTALS	15	113	3	141.7	215.1	0	0	13	118	0	131

*Company picks up Skycab (Squibb) RAM at Charlotte, NC destined for Orlando, FL. Data not available.

Table 16

Shipments of Radioactive Waste Transported Through Georgia and Inspected at Barnwell, South Carolina by Nuclear Regulatory Commission*

Date, 1980	SSR No.	Licensee/Shipper	Carrier	Trailer no.
Feb. 27-29	018949	Toledo Edison Co. Davis-Besse Power Sta Oak Harbor, OH	Home Trans Co.+	330039
	018955	Arkansas Power & Light Co. Arkansas N-1 Russelville, AR	McCormack	72234
	018960	Florida Power Crystal River Plant Crystal River, Florida	Chem-Nuclear	046
	018970	TVA, Browns Ferry Nuclear Plant Decatur, AL	Tri-State	TVA-83
	018979	Iowa Electric Light & Power Co. Duane Arnold Energy Center Cedar Rapids, IA	Hittman**	72235
Mar. 13-14	010116	Neoplastic Diseases Orlando, FL	Home Trans Co.	018
	019118	Commonwealth Edison Co. Dresden Plant Morris, IL	Hittman	72230
	019105	Commonwealth Edison Co./Quad-Cities Plant Chicago, IL	Hittman	72484
March 19	019169	Commonwealth Edison	Hittman	72230
	019173	Dresden Plant	Hittman	72229
	019180	Chicago, IL	Hittman	72235
	019170	TVA	Tri-State	4572
	019176	Chattanooga, TN	Tri-State	TV-83

*NRC letters RII:WWP 15000039/80-03 dated March 20, 1980;

RII:RAB 1500039, dated April 7, 1980; and
RII:RLW 15000039/80-05, dated April 14, 1980.
No items of noncompliance were found.

+ This shipment probably came through Georgia; however Home Transportation Company is now by-passing Georgia from subject location by using alternate routes.

**Hittman has 27-28 shipments per month through Georgia. It was also reported that permits for compliance with Rules of the State Department of Transportation, Chapter 672-10, Transportation of Hazardous Materials have been submitted.

Table 17

Monthly Summary of RAM Shipments, Delta Cargo Terminal, Atlanta, Outbound*

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks
May										
9	Atlanta	Lexington	Xe-133	0.010	-		1			NEN RAM
10	Atlanta	Lexington	Tl-201	0.004	-		1			NEN RAM
10	Atlanta	Lexington	Xe-133	0.100	-		1			NEN RAM
15	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckr RAM
15	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckr RAM
15	ORD	BNA	P-32	0.001	-	1				Amersham I
15	ORD	BNA	H-3	0.101	-		1			Amersham I
16	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckr RAM
16	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckr RAM
20	Atlanta	TYS	I-131	0.009	0.4			1		Mallinckr RAM
24	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
24	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
24	Atlanta	MCO	Xe-133	0.040	-		1			NEN RAM
24	Atlanta	MCO	Tl-201	0.006	-		1			NEN RAM
28	Atlanta	MCO	Xe-133	0.060	-		1			NEN RAM
28	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
28	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
28	Atlanta	MIA	Tl-201	0.006	-		1			NEN RAM
28	Atlanta	MIA	Tl-201	0.008	-		1			NEN RAM
28	Atlanta	MIA	Xe-133	0.080	-		1			NEN RAM
				TOTAL	0.8	1	14	5	0	

*Data were obtained from Delta Restricted Articles to Pilot Notification forms.

Table 18

Monthly Summary of RAM Shipments, Eastern Cargo Terminal, Atlanta, Outbound *

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III
May									
1	Atlanta	MSY	H-3	0.015	-		1		
1	EWR	MSY	I-131	0.014	2.1				1
1	ORD	AGS	Fe-59	0.001	0.2			1	
1	Atlanta	JFK	Y-90	0.46	1.5				1
1	Atlanta	ORD	Y-90	0.36	1.5				1
5	ORD	BHM	Ga-67	0.013	0.5			1	
6	Atlanta	MGM	Mo-99	0.45	2.0				1
6	ORD	CHA	Ga- 67	0.012	0.4			1	
6	ORD	CHA	I-123	0.002	0.1			1	
6	Atlanta	CHA	Tl-201	0.004	-		1		
7	Atlanta	LEX	Tl-201	0.004	-		1		
7	Atlanta	CHA	Tl-201	0.006	-		1		
7	TLH	PHL	I-125	768 uCi	-		1		
7	Atlanta	BHM	Se-75	0.001	0.2			1	
7	DFW	MLU	Ga-67	0.003	0.1			1	
7	ATL	MSY	H-3	0.025	-		1		
7	ATL	CHS	Se-75	0.001	0.2			1	
8	ATL	CHA	I-123	0.004	0.1			1	
8	ATL	PNS	I-125	10 uCi	-	1			

8	ATL	MEM	Tl-201	0.012	-		1		
8	ATL	LEX	Tl-201	0.004	-		1		
8	ATL	CHA	Tl-201	0.004	-		1		
8	ATL	CHA	Tl-201	0.002	-		1		
8	ATL	CHA	Tl-201	0.002	-		1		
13	ATL	MGM	I-131	0.450	2.0				1
13	ATL	CHA	Tl-201	0.004	-		1		
14	Unknown	GNV	Unknown (Solution Sodium Iodine)	0.010	Unknown			1	
15	EWR	MSY	I-131	0.014	3.0				1
17	DTW	AGS	I-131	0.013	0.6			1	
22	ATL	TPA	I-131	0.008	1.1				1
22	ATL	CHA	Co-57	2.6 uCi	0.1			1	
23	Unknown	MSY	In-125	< 0.001	-	1			
23	Unknown	MSY	I-131	0.014	3.0				1
25	LAC	MIA	C-14	0.002	-		1		
26	LAX	BHM	I-125	0.002	-		1		
27	ATL	MIA	Tl-201	0.002	-		1		
27	ORD	CHA	I-123	0.003	0.1			1	
28	Unknown	MSY	I-125	0.001	-		1		
			Totals	1.9	18.8	2	16	12	8

Note: Data were obtained from Eastern Restricted Articles forms.

Table 19

Monthly Summary of RAM Shipments at Eastern Cargo Terminal, Atlanta, Terminating*

1980 Date	Origin	Isotope	Curie	Category TI	Ltd	I	II	III	Remarks**
May									
1	STL	I-131	0.011	0.4			1		
5	EWR	I-125	< 0.001	-	1				Picked up by Sonic Deliv.
5	STL	Cr-51	0.001	0.1			1		
5	EWR	Mo-99	2.3	1.6				1	
5	EWR	Mo-99	2.3	1.6				1	
5	EWR	Mo-99	1.411	1.3				1	
6	STL	Mo-99	5.0	3.8				2	
7	STL	I-131	0.099	1.8				2	
11	LGA	I-123	0.0003	0.1			1		
12	STL	I-131	0.060	1.5				1	
12	LGA	I-123	0.0003	0.1			1		
13	LGA	I-123	0.0003	0.1			1		
13	STL	I-131	0.056	1.0				1	
13	STL	I-125	0.0002	-	1				
13	STL	I-125	0.0002	-	1				
13	EWR	Mo-99	Unknown	5.5				4	
13	EWR	I-125	< 0.001	-	1				Picked up by Sonic Deliv.
13	EWR	Cr-51	0.0014	0.1			1		" "
13	EWR	Co-57	2.8 uCi	0.1			1		" "
13	STL	Mo-99	5.0	3.8				2	
14	BUF	I-131	0.037	0.7				1	
14	LGA	I-123	0.0003	0.1			1		
14	STL	Cr-51	0.001	0.1			1		
15	EWR	Cr-51	0.0069	0.6			1		Picked up by Sonic Deliv.
15	EWR	Co-57	2.8 uCi	0.2			1		" "

18	LGA	I-123	0.0003	0.1		1		
19	STL	I-131	0.036	1.2			1	
19	LGA	I-123	0.0084	0.4		1		
19	LGA	Ga-67 Xe-133 I-123	0.010 0.010 0.009	0.7		1		Overpack
19	AUS	Cd-109	0.005	-	1			Deliv. Co unkn
19	AUS	Fe-55	0.045	(Exempt)				Deliv. Co unkn
20	STL	Mo-99	5.0	3.8			2	
20	LGA	I-123 Ga-67	0.0084 0.024	0.5		1		Overpack
20	EWR	Mo-99	1.4	1.3			1	
20	EWR	Mo-99	2.3	1.6			1	
20	EWR	Mo-99	2.3	1.6			1	
20	STL	I-125	0.001	0.1		1		
21	STL	I-131	0.19	1.6			1	
21	STL	I-131	0.081	1.2			1	
22	EWR	I-125	< 0.001	-	1			Picked up by Sonic Deliv.
22	STL	I-131	0.005	0.2		1		
22	STL	Ga-67	0.020	0.5		1		
26	EWR	Mo-99	2.3	1.9			1	
26	EWR	Mo-99	2.3	1.9			1	
26	EWR	Mo-99	1.1	1.6			1	
26	EWR	Mo-99	0.56	1.0			1	
26	LGA	I-123	0.0048	0.2		1		
26	LGA	Xe-133	0.020	-	1			
26	LGA	Xe-133 I-123 Ga-67	0.040 0.012 0.040	0.7		1		Overpack
27	LGA	Co-60	2 uCi	0.1		1		Picked up by Sonic Deliv.
27	STL	I-131	0.056	1.3		3		
27	LGA	I-123	0.0018	0.1		1		
27	LGA	Xe-133 Ga-67 I-123	0.030 0.024 0.0096	0.6		1		Overpack

7	STL	Mo-99	5.0	3.8				2	
8	STL	I-125	0.0002	-	1				
8	STL	I-131	0.053	0.7			1		
9	STL	I-131	0.033	0.7			1		
9	STL	Ga-67	0.028	0.1			1		
9	EWR	I-131	0.012	0.3			1		(1)
		TOTALS	39.2	54.4	7	1	30	30	

Data were obtained from airbills, shipping certificates and restricted articles forms.

*RAM picked up by Purolator Courier unless otherwise indicated.

OTE: 1. Picked up by Sonic Delivery. Air bill showed five pieces at 86 lbs; however, it is unknown if other 4 pieces were RAM. Only shipper's certificate, (Atlanta 1/5) was present, which agreed with air bill.

Table 20

Monthly Summary of RAM Shipments: Emery Air Freight, Atlanta

Date, 1980	Origin	Destination	Isotope	Curie	Category TI	Ltd I	II	III	Remarks
May									
1	Atlanta, GA	Chicago, IL	Yttrium	Unknown	unk			1	Via Delta AB006 ATL-1878-8965
2	Oak Ridge, TN	Gamma Industries	Ir-192	7,801	1.4			1	
		Baton Rouge, LA	Ir-192	7,585	1.3			1	
7	Atlanta, GA	Dallas/Ft Worth, TX	Kr-85	unknown	unk	unknown			Air bill cross referenced to RAM on Flying Tiger shipments on May 7, 1980. RAM come from GA Tech.
28	Oak Ridge, TN	Baton Rouge, LA	Ir-192	8,363	1.5			1	
30	Oak Ridge, TN	Baton Rouge, LA	Ir-192	7,938	1.6			1	
unknown	Oak Ridge, TN	New Orleans, LA	Ir-192	5,945	0.7			1	
			Totals	37,632	6.5			6	

Note: Data obtained from inbound/outbound air bills.

Table 21

Monthly Summary of RAM Shipments: Flying Tiger, Atlanta*

Date, 1980	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks
May										
7	Oak Ridge, TN (BNA Airport)	San Francisco, CA	Kr-85	30	0.3			1		Emery Air Freight to Atlanta
7	GA Tech Atlanta, GA	Dallas, TX	Kr-85 H-3	1.8 0.53	1.5				1	Emery Air Freight
16	Knoxville, TN	San Francisco, CA	H-3	2,382	-		1			Airborne (Cape Air Freight)
22	Oak Ridge, TN	Industrial Nuclear Co San Francisco, CA	Ir-192	3,688	0.8			1		
27	3 M St Paul, MN	3 M Caroline, Puerto Rico	Po-210 Po-210 Po-210	0.1 0.4 0.85 (total)	- - -		1 1 5			Bonded in ceramic, solids
31	Oak Ridge, TN	Industrial Nuclear Co Foster City, CA	Ir-192	3,612	0.4			1		
			Totals	9,716	3.0	0	8	3	1	

*Data were obtained from air bills, air way bills and shipper's certificates.

Table 22

Monthly Summary of RAM Shipments, Republic (formerly Southern) Airlines, Atlanta, Outbound*

Date, 1980	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks
May 1980										
12	Orangeburg, NY	New Orleans, LA	I-125	3.5 uCi	-	1				Profit by Air shipper
13	Orangeburg, NY	New Orleans, LA	I-125 Co-57	3.0 uCi 1.5 uCi	-	1				Overpack Profit by Air shipper
14	Unknown	Memphis, TN	Unknown	unknown						Ab 032 ATL 5720-8126 did not reflect RAM: however, Restriction Articles Pilot Notification indicated RAM NOS.
16	Orangeburg, NY	New Orleans, LA	Co-57	3.0 uCi	-	1				Profit by Air shipper
20	Skycab East Brunswick, NJ	Panama City, FL	Mo-99	unknown	1.6				1	
31	St. Louis, MO.	Sioux City, IA	Mo-99	1.5	1.7				1	Restricted Articles Pilot Notification listed radionuclide as Ga-67.
31	St. Louis, MO.	Bemidji, MN	Mo-99	3.0	2.5				1	Restricted Articles Pilot Notification listed radionuclide as Ga-67.
			Totals	4.5	5.8	3	0	0	3	

Appendix A

Observations

1. Observations of possible violations for monitored RAM packages and vehicle monitoring results are now listed in the applicable tables.

2. On May 17, 1980, at Purolator terminal, the driver of vehicle 15213 did not have shipping papers available for two boxes of I-125 with yellow II labels. Driver's manifest furnished by Profit By Air reflected medical test kits for subject RAM. Shipping certificates were available in sealed envelopes attached to the boxes. Vehicle was not monitored.

3. On May 22, 1980, Georgia EPD-DNR staff responded to a request from Eastern Airlines, Hartsfield Airport, Atlanta to assist in evaluating a potential radiological problem with some medical isotopes being shipped. Purolator Courier representative originally notified Eastern Airlines that one inner box of an overpack was broken open and contents were missing. Subsequent investigation and contact with the shipper, Medi-Physics, Inc. in New Jersey, indicated that the suspect box with missing contents was really just an empty box used to fill empty space left in the overpack. The overpacks were surveyed and smeared for removable contamination. No contamination was found. The aircraft was checked for contamination upon arrival in Miami and no gamma-ray contaminants were found.

4. On June 13, 1980, it was learned that a RAM package had been run over by a forklift at Delta Cargo,Hartsfield Airport, Atlanta on June 3, 1980. New England Nuclear recovered the damaged package of I-125, 15 mCi. Damage was restricted to external box and no damage to vials. It was reported that there was no release and no contamination from package.

5. On June 13, 1980, an Ir-192 package, type B container dropped from the loading belt while loading a Flying Tiger Aircraft. Package was visually checked and reloaded. Package was subsequently checked at Miami, Florida and it was reported to be undamaged.

6. On June 27, 1980, Georgia EPD-DNR staff received a call from EPA that U.S. Customs had been concern about leak test requirements on an empty radioactive material container from Germany going to Oak Ridge National Laboratory. Oak Ridge advised that cask must be certified and tested prior to shipment. Courier and U.S. Customs were advised of this.

Table #22

*Data were obtained from air bills and shipper's certificates or Pilot Notification forms. There was no record of any RAM terminating in Atlanta, Georgia during this period.

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M E M O R A N D U M

TO: Director, Radiological-Occupational Health Unit
Georgia Department of Human Resources

Attention: Mr. Willard Ingram

FROM: Bernd Kahn, Director
Environmental Resources Center

DATE: November 26, 1980

SUBJECT: Eighth Quarterly Report of Progress (July 1 - September 30, 1980) of Extended State Transportation Surveillance Program - Radioactive Materials - under agreement between Georgia Department of Human Resources and Georgia Institute of Technology

The three-year program of monitoring RAM packages and RAM transport vehicles, measuring radiation exposures of RAM workers, and determining the magnitude of RAM shipments in Georgia was completed this quarter. In the last 3-month period, thermoluminescent dosimeters (TLD's) were again issued to drivers and handlers who were known to be in contact with RAM, and were also placed behind drivers' seats and at terminals to measure radiation exposures. Exposure rates at vehicles that carried RAM and at terminals that stored RAM were also measured with survey meters on several days per month. Compliance with other RAM transport regulations was checked during these surveys. Information concerning the number of RAM packages and vehicle trips and the type of RAM was obtained by direct observation and from various records.

The measured exposures to RAM workers and some control persons are listed in Tables 1a to 1i, together with annual averages based on these measurements and the listed values for earlier periods. Annual exposure rates were obtained by multiplying the summed exposures by the ratio of 365 to the number of days for which measurements were obtained. No averages are given when dosimeters were only worn for brief periods because of lack of cooperation or change of work. Average annual exposures for the period before December 1979 were given in the Annual Report for the second year of the study. Background radiation exposures are believed to be in the range 50 - 100 mR/year. Elevated levels are shown in Tables 1e - 1i. One worker exceeded 5,000 mR/yr above background (see Table 1h), but there is a

question concerning the reliability of his participation in the measurement program (see footnote to Table 1h). Eight other workers had exposures between 500 and 5,000 mR/yr above background.

The results of monitoring at drivers' seats with TLD's, summarized in Tables 2a and 2b, show 7 vehicles where the exposure exceeded 500 mR/yr above background. Although these values do not necessarily indicate that the drivers were exposed at the same levels, they confirm elevated personnel dosimeter readings. Of concern are the elevated readings in Table 2b, which are believed to be associated with a relatively cursory radiation protection program by the carrier.

The TLD's installed at walls and pillars in RAM terminals showed some elevated readings in all terminals except F and H (see Table 3). Annual average exposures that exceeded 500 mR above background were observed only at terminal I. Some instances of questionable results due to RAM worker activities are indicated in the footnotes to Table 3.

The results of monitoring RAM packages and vehicles are reported in Tables 4, 5a, and 5b. Incidences of non-compliance with regulations are described in the "Remarks" columns. On five occasions, exposure rates above 2 mR/hr were observed in the cabs of vehicles (see Table 5a), and such readings were also found in the cockpit of the chartered aircraft (see Table 5b). The occurrence of RAM incidents and participation in special activities are described in Appendix A. A copy of the exemption under which two listed carriers transport RAM is given in Appendix B. Another carrier, Associated Courier, also operates under subject exemption. Transport by one of these -- Skycab Inc. -- appears to result in much of the elevated exposure to workers found during this period.

Detectable levels of radionuclides on smears of RAM packages and vehicles are summarized in Table 6. None of these exceeds the limit of 100 pCi/cm^2. All other smears (see for example the "excessive removable contamination" column in Table 5a) showed no detectable level of radioactivity.

Information concerning the number and type of RAM packages transported through the state is summarized in Tables 7a - 7f, based on the sources of information listed in these tables. Records on RAM shipments on Georgia highways are now being compiled by the state DOT in accord with state laws and regulations, and information under this program provided by DOT is given in Table 8. Permits are required for all loads of radioactive materials which are transported in an exclusive use vehicle, or are spent fuels, or have a Transportation Index in excess of 50, or are "Large Quantities" as defined in 49 CFR (more than 20 curies of Transport Groups I and II, more than 200 curies of Transport Groups III and IV, more than 5,000 curies of Transport Group V, more than 50,000 curies of Transport Groups VI and VII, or more than 5,000 curies of any "Special Form"

material). The carrier must report point of origin in or entrance to Georgia and destination or point of exit by telephone. Information obtained in the RAM study described here concerning carriers of radiopharmaceuticals was given to the State DOT so that all carriers that fall under provisions of the regulations would be included.

Visits to two users of industrial radiography sources together with State DHR staff showed exposure rates well below limits. The current DHR register of licensed radiographers is given in Table 9. Additional users are permitted to operate under agreements with other states where they are licensed. The known suppliers of Ir-192 radiography sources are listed in Table 10, and records of source shipments are given in Table 11.

The final report for the third year of the study is now being prepared.

Table 1a

Federal Express Personnel Radiation Monitoring with TLD's

		Exposure rate, mR/period			
TLD #	Position	12/13/79 to 3/20/80	3/20/80 to 6/23/80	6/23/80 to 9/17/80	Annual Average
1 A	Night Ramp Agent	19	NR*	NR	----

*NR - not recovered.

Table 1b

Delta Cargo Terminal Personnel Radiation
Monitoring with TLD's

TLD #	Shift	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
1	(B)	Clerk (office on 2nd floor) (Control)	25 (21)**	21	14	67
3	(C)	CSA Add-to/Spec Ser and Inbound	14	NR	29 (26)	56
4	(C)	Gate Agent, Main Terminal	NR*	NR	NR	--
5	(C)	Unload'g Aircraft, Main Term.	NR	NR	NR	--
6	(A)	SCSA	56 (58)	--	--	--
6A	(A)	SCSA Spec Ser Agent	14	14	12	52
7	(C)	CSA Add-to	16	15	10	53
8	(A)	CSA Sorter	15	15	10	52
9	(C)	Ticket Counter, Main Terminal	25 (21)	NR	NR	--
9A	(C)	SCSA Spec Ser Agent	16	15	10	54
10	(D)	SCSA Floor	16	17	11	58
11	(D)	SCSA Spec Ser Agent	20	17	14	67
12A	(D)	SCSA Add-to/outbound	NR	NR	NR	--
13	(D)	SCSA Sorting Area	NR	25 (27)	13	50
16	(C)	Spec Ser Agent	16	18	16	66
17	(C)	Spec Ser Agent	17	16	NR	64
18	(D)	SCSA	NR	25 (27)	10	46
19	(D)	SCSA	18	15	15	63
20	(E)	Gate Agent, Main Terminal	NR	NR	NR	--
21	(C)	Senior Ser Agent	NR	30 (27)	17	61

Shift: (A) 2315-0700 (B) 0800-1700 (C) 1500-2330 (D) 0700-1515 (E) 0500-1300

* NR - not recovered.

** Number of weeks other than shown in heading.

Table 1c

Eastern Cargo Terminal Personnel Radiation
Monitoring with TLD's

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
1	Ramp Service (1620-0020)+	16	16	13	59
2	Ramp Service (1620-0020)	14	NR*	23 (26)**	48
3	Ramp Service (0010-0810)	17	12	10	51
4	Supervisor (0800-1700)	21	17	14	69
5	R/S Front door and belt man (1620-0020)	22	20	13	72
6	Lead Ramp Service (0010-0810)	15	NR	NR	--
7	Ramp Ser Air Express (0900-1730)	19	10	NR	56
8	Ramp Ser Air Express (0110-0910)	28 (21)	14	12	60
9	Ramp Service (1620-0020)	--	--	17	--

* NR - not recovered.

** Number of weeks other than shown in heading.

\+ Working hours.

Table 1d

Profit By Air Terminal Personnel Radiation
Monitoring with TLD's

TLD #	Position	Exposure rate, mR/period 12/14/79 to 3/20/80	3/20/80 to 6/20/80	6/20/80 to 9/17/80	Annual Average
1	Driver, Atlanta area	20	15	14	65
2	Driver, Atlanta area	18	14	12	58

Table 1e

Purolator Courier Personnel Radiation
Monitoring with TLD's

TLD #	Position (route)	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
1	Office Secretary (Control)	14	17	12	57
3	Driver (028)	30 (21)+	24	17	79
4	Driver (028) (Sunday)	65	42	30	180
6	Driver (014)	36	20	14	92
7	Weekend Dispatcher (supervisor)	54	28	14	120
10	Driver (086)	NR*	70 (67)	14 (12)	55
11	Driver (037 & 086)	14 (4)	30	21	110
12	Driver and Terminal Sorter	52	81	101	310
14	Supervisor	19	17	12	63
15	Terminal Sorter	NR	--	--	--
18B	Driver (002)	22	17	16	72
19A	Driver (305)	17	16	11	58
36A	Driver/Supervisor	19	16	22**	75
39	Driver (035)	30 (21)	19	18	75
43	Driver (008)	NR		36 (41)	--
45	Driver (100)	NR	80 (27)	18	130
46	Driver (400)	76	NR	96 (26)	220
47A	Driver (045)	21	18	14	70
48	Driver (001)	14	15	12	54
49	Driver (016 & 004)	23	22	14	78
53	Driver (103)	NR	50 (27)	13	150

Table 1e (cont'd.)

TLD #	Position (route)	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
56	Sorter, weekends	NR	220 (42)	19	230
60	Driver (100 & 108)	NR	NR	81 (71)	59
63	Driver (011)	19	15	13	62
67	Driver (024)	40	33	31	140
68	Driver (051)	NR	31 (27)	14	59
70	Sorter, week nights	74	NR	33 (26)	140
74	Air Express	NR	NR	NR	--
75	Driver (400)	NR	NR	21	--
76	Driver (005)	22	18	13	70
77	Driver (006)	20	19	13	69
83	Supervisor, weekend	28	NR	27	107
84	Sorter, week nights	22	17	11	66
89	Driver (001)	21	18	16	72
90	Driver (080)	NR	NR	NR	--
93	Driver (015)	NR	NR	63 (40)	--
95	Driver (022)	NR	NR	45 (40)	--
96	Driver (080)	34	NR	40 (26)	96
99	Driver (008)	NR	NR	40 (41)	--
100	Sorter, weekend	53 (4)	NR	NR	--
102	Driver (101 & 103)	--	--	37 (26)	--
103	Driver (008)	--	NR	NR	--
105	Driver (008)	--	7 (8)	20	--
106	Driver (103)	--	--	71	--

* NR - not recovered.

\+ Number of weeks other than shown in heading.

** TLD issued October 25, 1979 and recovered on September 17, 1980 had a reading of 61 mR.

Table 1f

Associated Courier Personnel Radiation
Monitoring with TLD's

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/29/80	3/29/80 to 6/21/80	6/21/80 to 9/20/80	Annual Average
52	Driver	650 (21)+	NR*	930 (26)	1,750
73	Driver	900 (22)	NR	850 (28)**	1,830
104	Driver	---	NR	650 (26)	---
1	Driver	---	--	460 (16)**	---
2	Driver	---	--	420 (16)**	---

Notes: 1. Route - St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC, to West Palm Beach, FL.

2. Drivers sometimes switch to a Texas route from St. Louis, MO.

*NR - not recovered.

+ Number of weeks other than shown in heading.

** Until 10/14/80.

Table 1g

New England Nuclear Personnel Radiation
Monitoring with TLD's

TLD #	Position	Exposure rate, mR/period 12/16/79 to 3/30/80	3/30/80 to 6/22/80	6/22/80 to 9/28/80	Annual Average
1	Driver	1,100 (22)*	NR+	680 (26)	1,930
4	Driver	850 (22)	NR	690 (26)	1,680
5	Driver	NR	NR	1,060 (40)	1,380
6	Driver	NR	NR	1,040 (41)	1,320
7	Driver	--	--	230	---
8	Driver	--	--	270	---

Notes: 1. Route - Billerica, MA; Atlanta, GA; Nashville, TN; Oak Ridge, TN; to Billerica, MA. In June 1980, route includes Orlando, FL.

2. Drivers alternate on weekend trips.

* Number of weeks other than shown in heading.

NR+ Not recovered.

Table 1h

Skycab Personnel Radiation
Monitoring with TLD's

TLD #	Position	Exposure rate, mR/period 12/15/79 to 3/22/79	3/22/79 to 6/21/80	6/21/80 to 8/9/80	8/9/80 to 9/20/80	Annual Average
50	Driver	NR*	2,300+	380**	310++	6,000
59	Driver	1,300	NR	NR	NR	---

Notes: 1. Route - New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA; to Orlando, FL. Effective March 29, 1980, Orlando, FL route was dropped. Route now terminates in TN.

* NR - not recovered.

\+ Exposed for 34 weeks. In addition, another TLD (#50) issued July 28, 1979 was recovered on June 21, 1980 and had a reading of 1044 mR. However, TLD was not on person but in a box beside driver's seat.

** TLD was sent to Atlanta in RAM vehicle on August 2 and carried in another RAM vehicle enroute to Alabama before TLD was recovered. Reading does not entirely reflect driver's exposure.

++ TLD was reissued to driver, who placed TLD in his wallet; however, alternate driver found TLD in vehicle compartment at time of recovery. Therefore, reading does not entirely reflect driver's exposure.

Table 1i

Contractor for Skycab (Atlanta, Georgia): Personnel
Radiation Monitoring with TLD's

TLD #	Position (route)	Exposure rate, mR/period 4/26/80 to 4/28/80	5/2/80 to 6/20/80	6/20/80 to 9/20/80	Annual Average
1a	Driver (wallet)	29	120	140	660
1b	Driver (shirt pocket)	24	-	-	-
2	Driver	-	NR*	130	-
3	Driver	30	120	240	930
4	Driver	48	NR	43 (13)**	-

Notes:

1. Route - East Point, to Columbus, GA and intermediate stops at hospitals enroute to Montgomery and Birmingham, AL. On April 26, 1980, three drivers were in vehicle to learn route. Drivers are supposed to alternate for weekend runs.

   Driver #1 also transports RAM to hospitals in Atlanta area on Saturday evenings.

2. TLD #2 was issued to driver on May 2 and recovered on August 5, had a reading of 50 mR.

* NR - not recovered.

** Number of weeks other than shown in heading.

Table 2a

Vehicle Radiation Monitoring with TLD's - Purolator Terminal

TLD #	Vehicle #	Route ID	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
Purolator						
20	15180	(015)	NR*	NR	NR	---
22	15181	(028)	22	20	NR	81
23	15170	(039)	24	NR	12	70
24	15171	(015)	NR	NR	NR	---
25	15147	(a)	NR	NR	NR	---
26	15201	(086, 039)	30	Lost	16	89
27	15207	(014)	16	18	12	60
28	15194	(305)	39 (25)**	NR	29 (26)	70
29A	15182	(086)	36 (21)	18	13	75
30	16144	(028)	NR	NR	NR	---
32	56078	(b)	NR	NR	NR	---
33	37064	(018)	NR	18	11	58
34	15165	(024, 037, 080, 039)	NR	NR	NR	---
35A	15174	(081)	22	20	16	76
38	16111	(a)	NR	NR	NR	---
40	15149	(035)	34	28	31	120
44	15145	(008)	NR	NR	72 (40)	---
54	15203	(080)	30	29	24	109
57	15208	(100)	NR	NR	NR	---
61	16725	(400)	NR	NR	NR	---
62	15205	(008)	85 (38)	40	25	120
64	15178	(011)	NR	NR	94 (46)	---
65	912	(039)	22	18	10	65
66	15209	(081)	45	NR	43 (26)	120
69	15186	(051)	19	NR	27 (26)	60

Table 2a (cont'd.)

TLD #	Vehicle #	Route ID	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
72	15192	(081)	21	19	14	71
81	15218	(100)	NR	NR	NR	---
85	15214	(028)	80	29	30	180
86	16724	(400)	580 (26)	200	94	870
91	15289	(080)	NR	NR	77 (40)	---
92	15227	(305)	14	13	8.9	47
94	15223	(015)	47	NR	49 (26)	120
97	15212	(080)	43	NR	74 (26)	150
98	15224	(028)	29	23	14	86
101	15231	(028)	--	NR	9.8	---
Associated Courier						
87	P83094	(c)	580 (21)	330	210	1,240
New England Nuclear						
3	55	(d)	410	112	113	830
Skycab						
88	XRC92U (driver's seat)	(e)	1,400	2,100 (g)	430 (6)	6,200
	(passenger's seat)				670 (6)	---
Skycab						
3	XRC92U	(e)	--	870 (f)		---

Notes: (a) Atlanta to Birmingham, AL.
(b) Atlanta to SC.

Table 2a (cont'd.)

(c) St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC to West Palm Beach, FL.

(d) Billerica, MA: Atlanta, GA; Nashville and Oak Ridge, TN.

(e) New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA to Orlando, FL.

(f) TLD Skycab 3 was issued on October 25, 1979 and was recovered on June 21, 1980 (34 weeks). However, van was subsequently sold and TLD was carried in other vehicles. Routes and dates associated with subject reading are unknown.

(g) TLD was issued on March 29 and was recovered on August 9; however, local contractor driver carried TLD in his vehicle with RAM on August 2-3.

* NR - not recovered.

** Number of weeks other than shown in heading.

Table 2b

Vehicle Radiation Monitoring with TLDs - Contractor
for Skycab (Atlanta, GA)

TLD #	Vehicle #*	Exposure rate, mR/period 4/26/80 to 4/28/80	5/2/80 to 6/20/80	6/20/80 to 8/9/80	8/9/80 to 9/20/80	Annual Average
5	TEA 529 (behind driver's seat)	36	360	100 (1)	300	1,300
6	TEA 529 (behind passenger's seat)	--	510	NR	410	4,900
7	TEA 529 (behind rear seat)	250	1,560	(2)	1,980 (2)	9,900

Notes: 1. It was reported that TLD was inadvertently sent to NJ. Upon return, TLD was carried in vehicle compartment.

2. TLD reading was for more than 2 periods.

* East Point, Georgia to Columbus, Georgia with intermediate stops at hospitals to Montgomery and Birmingham, Alabama. Vehicle departs every Saturday night after transferring RAM from Skycab vehicle which started at East Brunswick, NJ.

Table 3

Site Radiation Monitoring with TLD's

TLD Location		Exposure rate, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80	2/13/80 to 5/15/80	5/15/80 to 8/12/80	8/12/80 to 9/10/80	Annual Average
Terminal A, Airborne							
1C*	Office, under desk	--	15	17	16	6.6	66
2	RAM Area, south wall	--	33	39	28	11	140
Terminal B, Airlift International (b)							
1C	Office, on wall	M+	34	30	--	--	130
2C	Breakroom, on wall	M	M	27	--	--	--
3	Left side RAM area, on wall	51	39	44	--	--	180
4	Center RAM area, on wall	M	M	40	--	--	--
5	Right side RAM area, on wall	M	46	24	--	--	140
6	Pillar south/east side outbound area	24	20	20	--	--	86
7	Wall, south side outbound area	45	43	38	--	--	170
8	Pillar, west end outbound area	M	16	21	--	--	74
9	Pillar, west end outbound area	M	18	26	--	--	88
Terminal C, Delta Cargo Terminal							
1C	North wall	32	29	32	24	10	120
2C	East wall	31	30	30	32	10	120
3	Inbound RAM (Hazardous Holding area)	46	38	47	43	15	180
4	Outbound RAM	19	M	21	16	7	76
5	East wall between doors 6 & 7	26	31	23	22	8	103
6	Pillar, east side opposite doors 6 & 7	32	27	25	22	8	107
7	Office by radiac meters	--	--	--	--	109 (50)**	110

Table 3 (cont'd.)

TLD Location		Exposure rate, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80	2/13/80 to 5/15/80	5/15/80 to 8/12/80	8/12/80 to 9/10/80	Annual Average
Terminal D, Eastern Cargo Terminal							
1	RAM area, terminating bins 3 & 4	66	41	89	73	8	260
2	RAM area, terminating bins 1 & 2	54	52	71	28	12	200
3C	Steel pillar, SE end of terminal	16	15	16	12	6	60
4	RAM area, outbound	22	26	14	12	6	75
5	RAM area, inbound on steel pillar	15	14	15	15	12	66
6	RAM area, terminating bins 2 & 3	53	41	71	170	10	320
7	RAM area, terminating bins 4 & 5	52	31	45	38	7	160
8	Left side of pickup door #1	30	22	30	70	7	150
Terminal E, Emery Air Freight							
1C	Office, under desk	M	16	15	15	6.2	64
2	RAM area, on post	32	14	30	760 (c)	29	130
Terminal F, Federal Express							
1C	Office	M	22 (a)	23	24	9	95
2	End of roller conveyor, east terminal	23	21	30	22	7	96
3	Bin pkg holding area outside ofc		20	M	25	9	95
Terminal G, Flying Tiger							
1C	Office	22	22	23	21	8	90
2	Wall, left corner RAM area	36	98	60	17	6	200
3	On pillar center of RAM area	34	88	260	M	6	470
4	New RAM area, on guard rail, NE side of building		--	--	40	35	--
5	New RAM area, on pillar, NE side of building		--	--	34	33	--
6	New RAM area, on post near overhead door, east side of bldg		--	--	42	140	--
7	New RAM area, on pillar, NE side of building		--	--	37	17	--

Table 3 (cont'd.)

TLD Location		Exposure rate, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80	2/13/80 to 5/15/80	5/15/80 to 8/12/80	8/12/80 to 9/10/80	Annual Average
Terminal H, Profit by Air							
1C	Office	M	17	M	19	6	75
2	RAM area, east wall	19	18	17	21	10	80
3	RAM area, post to left of east wall	20	20	20	16	6.8	77
Terminal I, Purolator							
1C	Breakroom on water fountain	M	15	16	15	4.7	62
2	West wall, between door 2 & 3	34	54	80	47	12	210
3	By dispatcher's window, inside cabinets	320	290	180	120	74	920
4	North wall, left side men's latrine	72	68	340	200	20	650
5	South wall, between doors 4 & 5	270	200	280	270	40	990
6	South wall, between doors 7 & 8	M	450	530	630	57	2,000
7	North wall, by door 16	92	62	69	65	18	290
8	South wall, between doors 1 & 2	57	35	52	163	88	370
9	East side between doors A & B	690	560	1,000	660 (d)	230	2,900
10	East side between doors B & C	560	440	760	460	200	2,300

Notes: a. F (1C) TLD was attached to file cabinet in office which was subsequently moved out in the terminal area in a fenced storage area.

b. Terminal B, Airlift International, in Atlanta, Georgia ceased operations effective May 15, 1980.

c. Annual average does not include this value. On June 20, 1980, TLD 2 was missing; but it was recovered on August 12, 1980. The high reading was discussed with supervisor but could not be resolved.

Table 3 (cont'd.)

A replacement TLD #2 installed on June 20, 1980 and recovered on August 19, 1980 had a reading of 76 mR.

d. On July 30, 1980, a driver returned TLD #9 which he found in his vehicle. TLD was also held in terminal office until recovered; therefore, reading is questionable.

* Denotes Control TLD.

\+ M: Missing.

** Number of weeks of exposure in parentheses.

Table 4

Monitored RAM Packages

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
July 30 Eastern Cargo	0.044	I-131	1.0	III	Mallinckrodt, overpack, St. Louis, MO to Atlanta (1.2)
July 30 Purolator	0.0012	S-35	---	I	New England Nuclear Boston, MA to Atlanta
Purolator	0.0015	P-32	---	I	NEN Boston, MA to Atlanta
July 30 Flying Tigers	0.010	Ni-63	---	I	SRI, Birmingham, AL to Bendix Corp., Baltimore, MD. Package returned to shipper because of air bill errors. Package authorization and type were not on box.
Flying Tigers	0.010	C-14	---	I	Amersham, no address on package and pprwork missing. Sticker showed SJU (San Juan, PR.) Tracer action was submitted. Assistance from Profit By Air was requested to help obtain paperwork so package could be shipped.
August 9 Purolator	0.077	I-125	0.2	II	Amersham to Ft. Gordon, GA (0.2)
Purolator	0.5	Mo-99	1.5	III	Mallinckrodt to Canton, GA (1.0)

Table 4 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
Purolator	1.0	Mo-99	1.2	III	Mallinckrodt to Gainesville, GA (1.0)
Purolator	0.75	Mo-99	2.3	III	Mallinckrodt to Milledgeville, GA (1.3)
Purolator	0.010	I-131	0.5	III	Mallinckrodt to Columbus, GA (0.6)
August 12 Flying Tigers	250	Kr-85	1.2	III	Oak Ridge, TN to Tris Tech International, Burbank, CA, USA/5552/B container (1.8)
Flying Tigers	0.011	Co-60	2.0	III	Laboratorium, Stuttgart, West Germany to Monsanto Textile, Guntersville, AL, RAM arrived on Sabena Airlines (1.8)
August 12 Delta Cargo	15.7	Mo-99	2.0	III	Union Carbide, NY airport to Atlanta. First of this type shipment noted in 3 years. (2.0)
August 12 Eastern Cargo	3.0	Mo-99	2.5	III	Mallinckrodt overpack to Miami, FL (2.2)
Eastern Cargo	1.5	Mo-99	1.7	III	Mallinckrodt to Miami, FL. Only 1 label on package (2.0) Above 2 RAM were involved in an incident at airport. Only 2 of 9 packages in shipment were monitored. Another package had a Profit By Air label over the III label.

Table 4 (cont'd.)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
August 13					
Kenworthy Air Freight	1.0	Mo-99	1.2	III	Mallinckrodt overpack. RAM returned to Mallinckrodt by Profit By Air (1.0)
August 19					
Eastern Cargo	1.5	Mo-99	1.7	III	Mallinckrodt, St. Louis, MO to Pensacola, FL (1.3)
August 19					
Zantop Airlines	1.4	Mo-99	1.3	III	Squibb overpack Newark, NJ Airport to Atlanta. Skycab shipper. (1.3) Three other overpacks of Mo-99 in shipment not monitored. This was first observation of RAM at Zantop Airlines.
September 10	0.4	Kr-85	0.6	II	GA Tech to University of
Emery Air	0.1	H-3			Texas (0.6)
Freight	0.2	Kr-85	0.3	II	GA Tech to University of
	2.3	H-3			Texas (0.3)
	0.9	Kr-85	1.0	III	GA Tech to University of
	0.6	H-3			Texas (1.0)
September 10					
Flying Tigers	0.16	enriched uranium	0.2	II	Oak Ridge to France. Type B USA/0002/B container. Fissile RAM paperwork not checked (0.2)
Flying Tigers	0.26	enriched uranium	0.2	II	same as above

Table 4 (cont'd.)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
Flying Tigers	0.010	Cs-137	0.1	II	Halliburton Services, Ducan, OK to Miami and to Venezuela. Density gauge. Shipper's certificate on box had special form encapsulation 0.50 curies. Box not marked as special form. Three II labels were on box but not on opposite sides of box. Other paperwork not checked (0.1)
Flying Tigers	0.00045	Ra-226	1.0	II	San Juan, PR to Maintenance Management, NY, NY. Paperwork not checked (0.9)
September 17					
Delta Cargo	0.000015 0.013	Co-57 I-131	0.5	II	Squibb overpack, Skycab shipper. Staples for security seal. Newark, NJ to Atlanta (0.3)
Delta Cargo	0.012	Tl-201	---	I	NEN to Atlanta, GA
Delta Cargo	0.004	Tl-201	---	I	NEN to Ft. Gordon, GA
Emery Air Freight	0.001	C-14		I	EPA, Monticello, MN to US EPA, Gulf Breeze, FL. Bolt through locking ring used as seal. Two I labels on drum but not on opposite sides. No package authorization.
Emery Air Freight	1.6 0.5	Kr-85 H-3	0.9	II	GA Tech to Texas Department of Water Resources, Austin, TX (0.8) Three other like items in shipment but not monitored.
September 17					
Flying Tigers	---	---	---		Container, USA/6697/B type B, from Industrial Nuclear Company to Union Carbide, Oak Ridge, TN, marked empty, had a surface reading of 0.6 mR/hr and 0.03 mR/hr at 3 ft. Paperwork not checked.

Table 4 (cont'd.)

1980 Date and Location	Amount, Ci	Transportation Isotopes	Index	Category	Remarks*
September 18					
Eastern Cargo	0.026	I-131	0.8	III	Mallinckrodt overpack to Birmingham, AL (1.1)
Eastern Cargo	0.072	I-131	1.0	III	Mallinckrodt overpack to Atlanta, GA (1.9)
Eastern Cargo					Mallinckrodt box marked USA DOT 7A, type A, no labels, had a surface reading of 12 mR/hr and 0.6 mR/hr at 3 ft. Above three pieces on air bill 007 STL 20838156, dated September 17, were misrouted to Nashville, TN. RAM arrived Atlanta, September 18, at 1125 hours. Shipper's certificates accounted for the two I-131 packages; however, it read "medical supplies, not radioactive, no labels required," for the third piece. Same package was again remonitored at Purolator and had a TI reading of 0.6. Shelby Memorial Hospital, Alabaster, AL received this package. It was notified of above on September 22. Mallinckrodt was also notified. Box contained I-131. Mallinckrodt advised that corrective action had been taken and health physics will monitor RAM packages.

Table 4 (cont'd.)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
September 18					
Purolator	0.003	Ga-67	0.1	II	Mallinckrodt to Anniston, AL, (0.1)
Purolator	0.002	Tl-201	0.1	II	Mallinckrodt to Birmingham, AL (0.1)
Purolator	0.005	P-32	0.1	II	Mallinckrodt to Birmingham, AL (0.1)
September 20					
Purolator	0.077	I-125	0.2	II	Amersham to Sylacauga, AL, Profit By Air envelope covered one II label. Staples were used as security seal (0.2)
Purolator	0.0015	H-3/C-14	---	I	U of Texas, Houston, TX to Columbia, SC
Purolator	0.0018	I-131	0.4	II	Squibb to Augusta, GA (0.3)
Purolator	0.0001	I-125	---	Ltd.	Rocke Diagnostic, Belleville, NJ to Ft. Gordon, GA. Shipper's certificate indicated industrial type package.

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* Type A package unless otherwise specified.
Origin and destination listed unless shipments were exclusively in Georgia.
Measured TI shown in parentheses.
Pertinent observation noted.

Table 5a

Vehicle Monitoring Results - Purolator Terminal

1980 Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Excessive Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
July 30	(1)	15207	014	0.02	0.2	0.04	0.1	unknown	right rear	yes	NA	
August 9		P83094	(A)	0.2	45	9	249.1	see Table 6	rear	yes	yes	
August 9	East Pt., GA	XRC92U	(B)	2.5 10 (sleeper)	90	unk	unk	none	full	unk	1 miss.	1 RAM package fell out when door was opened.
August 9	East Pt., GA	XRC92U	(B)	0.4 0.8 (sleeper)		unk	unk	none	rear	unk	1 miss.	Vehicle re-monitored after off-loading RAM on next vehicle. RAM for Purolator, Atlanta & TN was rearranged in vehicle.
August 9	East Pt., GA	TEA 529	(C)	3.8 5	70	7	143.6	none	rear	yes	yes	Vehicle to deliver Atlanta RAM to hospitals enroute to Alabama.
August 12	Eastern Cargo, Atlanta, GA	15235	035	0.6	28	unk	13.7	unk	rear	yes	yes	
September 17	Emery Air Freight East Pt., GA	125351-2	(D)	0.6	5	0.8	2.4	unk	front	yes	NA	

Table 5a (cont'd.)

1980 Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Excessive Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
September 18		15227	108	0.05	0.7	0.2	0.8	unknown	right rear	yes	yes	
		15207	014	0.04	0.1	0.08	0.4	unknown	rear	yes	3 displayed	Front placard was covered by air deflector; however, no III Label RAM was on vehicle.
September 18		15231	028	0.03	unk	unk	0.7	unknown	rear	yes	yes	TI and documents do not reflect RAM package destined for Shelby Memorial Hospital in AL that had a TI of 0.6.
September 20		P83094	(A)	0.19 0.3 (sleeper)	30	9	243.6	see Table 6	rear	yes	yes	
September 20	East Pt., GA	XRC92U	(B)	2.2 3.0 (sleeper)	45	4	unk	none	full	unknown	yes	
September 20	East Pt., GA	TEA 529	(C)	5.2	40	unk	unk	none	full	yes	yes	4 ft separation distance Skycab rep did not make survey of vehicle.
September 21	Charlie Brown Airport, Atlanta	NEN55	(E)	0.4 1.1 (sleeper)	11	3	300	none	front	yes	yes	
September 21		16724	400	0.6	25	2.4	46.8	unknown	rear	yes	yes	

Table 5a (cont'd.)

1980 Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Excessive Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
September 21		15233	028	0.6	32	unk	41.9	unknown	rear	yes	yes	
September 21		15252	015	0.1	20	2.2	30.6	unknown	rear	yes	yes	

Notes: (A) Associated Courier - St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC; to West Palm Beach, FL.

(B) Skycab - New Brunswick, NJ; to Atlanta, GA and Tennessee.

(C) Skycab - East Point, GA to Columbus, GA and Alabama.

(D) Emery - Atlanta area.

(E) New England Nuclear - Billerica, MA; Baltimore, MD; Alexandria, VA; Charlotte, NC; Atlanta, GA; Orlando,FL to Oak Ridge, TN and return to Billerica, MA.

(1) All locations were at Purolator Terminal, Atlanta, GA unless otherwise noted.

Table 5b

Aircraft Monitoring Results - Sajen Air

1980 Date	Location	Aircraft	Radiation levels, mR/hr			Transport Index	Package Placement	Proper Shipping Documents
			Cockpit	Surface	Six ft			
September 21	Charlie Brown Airport, Atlanta	N114SA	6.5	78	9	101.8	Center	yes

Notes:

1. NEN delivers RAM by tractor trailer to aircraft at Atlanta Airport on Sunday morning. Operation began in June.
2. Aircraft flies RAM to New Orleans, LA (TI 33.8); Jackson, MS (TI 23.2); Memphis, TN (TI 19.8); and Nashville, TN (TI 25) and returns to Manchester, NH empty.
3. Pilot, co-pilot, and aircraft had film badges.
4. Separation distance was 34 inches from pilot to RAM. A lead shield apron was draped over front of RAM to help reduce exposure.
5. Personnel were especially helpful and cooperative.
6. Aircraft #N114SA was a Piper Chieftain.
7. No removable contamination noted.

Table 6

Surface Contamination Measured by Smears
of Vehicles and RAM Packages

Date, 1980	Area, cm^2	Object smeared	Radionuclide level, pCi/100 cm^2			
			Se-75	Mo-99	I-131	Other
July 30	13,000	I-131 overpack	0.2	<0.05	<0.05	--
August 9	5,000	Mo-99, 3 packages	0.4	<0.2	<0.2	--
August 9	1,600	Associated Courier, rear bed	1.2	<0.2	<0.2	--
August 12	100	Mo-99 package at airport	<5	7.8	<5	--
August 12	100	Inside Mo-99 package at airport	<10	250	<10	--
August 12	1,200	Airport apron, gloves, etc.	<0.1	2.8	<0.1	--
August 12	100	Inside package at airport	<10	580	<10	--
August 12	2,900	Mo-99 package (repackaged after airport incident)	<0.1	0.14	<0.1	--
August 12	1,600	Mo-99 package at airport	0.3	0.12	<0.1	--
August 19	1,800	Mo-99 overpack	<0.1	<0.1	<0.1	(Co-60) 0.2
August 20	1,600	Associated Courier, rear bed	0.9	<0.2	<0.2	--

Table 7a

Summary of Weekend RAM Shipment Distribution by
Purolator Courier, Atlanta, Georgia from
Mallinckrodt (M)

1980 Date	Source	Destination	I-131	Mo-99	Misc	Activity, curie	TI	Category Ltd	I	II	III	Total
August 10	M	GA	17	22	1	23.9	44.1	0	0	14	26	40
September 21	M	GA	18	19	4	16.8	37.3	1	0	21	19	41

Table 7b

Summary of Weekend RAM Shipments Distribution
by Local Contractor for Skycab,
East Brunswick, New Jersey

1980 Date	Source	Destination	I-131	Mo-99	Misc	Activity, curie	TI	Category Ltd	I	II	III	Totals
August 9	Squibb	Columbus, GA	0	1	0	1.7	5.2	0	0	0	1	1
		Birmingham, AL	1	17	0	27.0	70.4	0	0	1	17	18
		Montgomery, AL*	1	16	1	17.3	52.2	0	0	2	16	18
		Atlanta (Piedmont Hosp.)	0	1	0	1.7	5.2	0	0	0	1	1
		Atlanta (Grady Hospital)	1	1	0	2.8	4.5	0	0	1	1	2
		Atlanta (Doctors' Hospital)	0	1	0	0.56	1.9	0	0	0	1	1
		Atlanta (Emory Hospital)	0	1	1	2.8	4.2	1	0	0	1	2
TOTALS			3	38	2	53.9	143.6	1	0	4	38	43
September 21	Squibb	Atlanta (Grady Hospital)	1	1	0	2.8	4.7	0	0	1	1	2
		Atlanta (Emory Hospital)	0	1	0	2.8	4.2	0	0	0	1	1
		Atlanta (Piedmont Hospital)	0	1	0	1.7	5.2	0	0	0	1	1
		Atlanta (Doctors' Hospital)	0	1	0	0.56	1.9	0	0	0	1	1
TOTALS			1	4	0	8.0	16.0	0	0	1	4	5

Note: Data for other routes were not obtained.
* Includes 4 Mo-99 generators destined for Florida.

Table 7c

Summary of Weekend RAM Shipments Distribution
by Associated Courier, St. Louis, MO to or
through Atlanta, GA per Bill of Lading (Shipping Papers)*

1980 Date	Source	Destination	I-131	Mo-99	Misc	Activity, curie	TI	Category Ltd	I	II	III	Totals
8/9	Mallinckrodt	Atlanta, GA (Purolator Courier)	17	22	1	23.9	44.1	0	0	14	26	40
		Charlotte, NC	8	46	2	46.1	89.5	0	0	8	48	56
		Athens, GA	2	1	1	1.0	1.5	0	0	3	1	4
		Waycross, GA	1	1	0	1.0	1.3	0	0	1	1	2
		Tampa, FL	2	29	1	49.6	67.2	0	0	1	31	32
		Ft Lauderdale, FL	1	18	2	31.8	39.5	0	0	2	19	21
		Gainesville, FL	0	2	0	3.3	3.0	0	0	0	2	2
		Ormond Beach, FL	0	1	0	4.1	3.0	0	0	0	1	1
TOTALS			31	120	7	160.9	249.1	0	0	29	129	158
9/20	Mallinckrodt	Atlanta, GA (Purolator Courier)	18	19	4	16.8	37.3	1	0	21	19	41
		Charlotte, NC	9	46	1	47.2	94.6	0	0	5	51	56
		Athens, GA	1	1	1	1.0	1.4	0	0	2	1	3
		Waycross, GA	1	1	0	1.5	1.8	0	0	1	1	2
		Tampa, FL	4	30	2	50.2	66.8	0	0	4	32	36
		Ft Lauderdale, FL	1	16	1	28.4	36.5	0	0	1	17	18
		Gainesville, FL**	0	1	0	2.5	2.0	0	0	0	1	1
		Sarasota, FL**	0	1	0	0.83	1.0	0	0	0	1	1
		Ormond Beach, FL**	0	1	0	4.1	3.0	0	0	0	1	1
		Jupiter, FL**	0	1	0	1.7	1.5	0	0	0	1	1
TOTALS			34	117	9	154.2	245.9	1	0	34	125	160

* Company picks up Skycab (Squibb) RAM at Charlotte, NC destined for Orlando, FL. Data not available.

** Records indicated RAM was from Union Carbide.

Table 7d

Summary of Weekend RAM Shipments Distribution
by NEN, Billerica, MA to or through Atlanta, GA
(Per trailer listing of load)

1980 Date	Destination	TI	No. of Mo-99 generators
September 21	NEN Atlanta Office	9	1
	NEN Atlanta Office (for Purolator Courier)	51.9	13
	Charlie Brown Airport Atlanta, GA for Sajen Air	101.8	25
	Orlando, FL	21.1	5
	Orlando, FL (Miami RAM)	27.2	4
	Orlando, FL (Tampa RAM)	47.0	9
	Birmingham, AL	42.0	19
TOTAL		300	76

Table 7e

Summary of Weekend RAM Shipments Distribution by
Sajen Air (formerly Golden Eagle), Manchester, NH
from Atlanta, GA (Per Shipping Certificates)

1980 Date	Source	Destination	TI
September 21	NEN	New Orleans, LA	33.8
		Jackson, MS	23.2
		Nashville, TN	25
		Memphis, TN	19.8
TOTAL			101.8

Table 7f

Monthly Summary of RAM Shipments,
Summit Airlines, Atlanta*

Date 1980	Origin	Destination	Isotope	Curie	TI	Category	Remarks
			OUTBOUND				
5/29	Oak Ridge, TN	JFK	H-3	5,000	--	I	
6/10	Universal Co Decatur, AL	CHL	Am-241 Cs-137	0.0084 0.04	0.5	II	NOS special form. Type A container.
6/24	Oak Ridge, TN	JFK	H-3	5,000	--	I	
7/11	Oak Ridge, TN	JFK	H-3	5,000	--	I	USA 5552/B container.
			TERMINATING				
May	NONE						
6/18	Micromedic Systems, Horsham, PA (PHL)	ATL	I-125	<0.002	--	Ltd.	

* Data were obtained from Air Bills and Pilot Notification Restricted Articles forms.

Table 8

Monthly Reports of Radioactive Waste/LSA/Casks
Shipped by Truck through Georgia (a)

1980 Date	Origin/Destination/Carrier	Number
July (b)	Alabama to South Carolina	
	Chem Nuclear	2
	Tri State	8
	Florida to South Carolina	
	Chem Nuclear	12
	McCormack	2
	Tri State	2
	Georgia to South Carolina	
	Chem Nuclear	2
	Tennessee to Florida (c)	
	Chem Nuclear	1
	Tennessee to South Carolina	
	Daily Express	1
	Tri State	1
	TOTALS	31
August	Alabama to South Carolina	
	Chem Nuclear	3
	Tri State	17
	Wyle Lab	1
	Florida to South Carolina	
	Chem Nuclear	11
	Tri State	1
	Georgia to South Carolina (Baxley)	
	Chem Nuclear	4
	Home	2

Table 8 (cont'd)

1980 Date	Origin/Destination/Carrier	Number
	Tennessee to South Carolina	
	Daily Express	1
	Hittman	19
	Tri State	3
	TOTALS	62
September		
	Alabama to South Carolina	
	McCormack	2
	Tri State	13
	Florida to South Carolina	
	Chem Nuclear	7
	Tri State	2
	Georgia to South Carolina (Baxley)	
	Chem Nuclear	4
	Home	2
	Tri State	2
	(Folkston)	
	Chem Nuclear	2
	South Carolina to Folkston, GA	1
	Tennessee to South Carolina	
	Chem Nuclear	1
	Hacke	3
	Hittman	21
	Tri State	1
	TOTALS	61

Notes: (a) Data were obtained from Georgia Department of Transportation, Monthly Report of Hazardous Material Movements, and telephone contact with carriers regarding resolution of questions for several shipments. The Georgia Act does not apply to transport, delivery or acceptance for transport of radioactive materials under the direction or supervision of the United States Nuclear Regulatory Commission or the Department of Defense where such transport, delivery or acceptance for transport

Table 8 (cont'd.)

are escorted by personnel designated by or under authority of those agencies.

(b) July figures do not include 27-28 shipments by a major carrier of radioactive waste from the northern states through Georgia; however, those shipments are included in August and September totals.

(c) This shipment, consisting of 45 drums, reportedly from Chattanooga, TN to Florida could not be confirmed from information available.

Table 9

Radiographers According to DHR Register,
April 1980

Power Piping Company
Law Engineering Testing Company
Combustion Engineering, Incorporated
Metallurgical Engineers of Atlanta
X-Ray Engineering Company
Delta Airlines, Incorporated
Nuclear Energy Service, Incorporated
American Testers, Incorporated
Glover Machine Works, Incorporated
H & G Testers, Incorporated
Industrial Inspection Industries, Incorporated
Daniel International
B & W Construction Company
Chicago Bridge and Iron Company
McPherson Nondestructive Testing
E.V. Camp Steel Works
Pullman Power
Pittsburgh Testing Laboratory
Accu-Ray, Incorporated
Hitco of Louisiana, Incorporated
Southeastern Testing Services
Georgia State Department of Transportation
Industrial NDT Company, Incorporated
Consolidated X-Ray Service Corporation

Table 10

Ir-192 Suppliers to Radiographers
in Georgia

Gamma Industries, Baton Rouge, LA
Gulf Nuclear Incorporated, Webster, TX
Source Production & Equipment, Kenner, LA
Technical Operations (Rad Production
Division), Burlington, MA

Table 11

Shipments of Ir-192 Radiography Sources
to and from Two Radiographers*

Supplier	Carrier	Date	Activity, curies	TI	Category	Remarks
Source Production and Equipment	Emery Air Freight**	4/2/79	0	--	I	Returned shipping container (depleted U)
Source Production and Equipment	Federal Express**	4/30/79	102	unk	unk	
Source Production and Equipment	Red Ball Express**	4/30/79	0	--	--	Returned shipping container (depleted U)
Source Production and Equipment	Federal Express**	5/30/79	102	2.0	III	
Source Production and Equipment	Federal Express**	5/31/79	28	0.2	II	Returned source
Source Production and Equipment	Federal Express**	9/28/79	110	2.5	III	
Source Production and Equipment	Federal Express**	2/6/80	105	1.0	III	
Source Production and Equipment	Federal Express**	2/4/80	8	1.0	III	Returned source
Technical Operations (RAD Prod. Division)	Roadway Express**	5/31/79	0	--	--	Returned 2 shipping containers
Technical Operations (RAD Prod. Division)	Roadway Express**	6/11/79	1.7 5.5	unk unk	unk unk	Returned 2 sources
Gamma Industries	Federal Express	8/22/79	80	2.0	III	
Gamma Industries	Federal Express	3/31/80	103	2.5	III	
Gamma Industries	Mercury Freight	4/8/80	10	0.5	II	Returned source
Gamma Industries	Federal Express	6/4/80	100	2.8	III	

Table 11 (cont'd.)

Supplier	Carrier	Date	Activity, curies	TI	Category	Remarks
Gulf Nuclear	Federal Express	9/18/79	100	2.0	III	
Gulf Nuclear	Mercury Freight	7/3/80	7	0.5	II	Returned source

Notes: * Information was from company records.

** McPherson Nondestructive Testing, Inc., Norcross; all others were for Law Engineering Testing Co., Atlanta.

Appendix A

Observations

1. Observations of possible violations for monitored RAM packages and vehicle monitoring results are listed in the applicable tables.

2. On August 12, 1980, Georgia Department of Natural Resources, Environmental Protection Division, responded to an incident which occurred on the apron by Lockheed Air Terminal, North Cargo Building, involving the unloading of freight from an Evergreen Airlines aircraft. At approximately 0535 hours, a pallet of Mo-99 generators was being transferred from the aircraft to a loading dolly. It was reported that the pallet of 9 generators jumped the pin retaining stop and Mo-99 packages fell to the ground. One package cardboard box opened, exposing only the plastic generator case. Readings of packages and smears of apron and packages were taken. No radioactive materials were released. Packages were released to Profit By Air, the shipper, for repackaging. This incident, although minor, caused considerable news media interest.

   RAM was enroute from St. Louis, MO to Miami, FL. It was noted that a Profit By Air label was covering one of the III labels on the Mo-99 package. Kenworthy Air Freight was handling the freight.

3. On August 19, 1980, the Profit By Air manager was informed of the problem encountered with Profit By Air envelopes and labels placed over RAM package radiation labels. This has been a recurring problem.

4. On August 21, 1980, the Profit By Air manager was contacted to assist Flying Tigers to obtain lost paperwork for a C-14 package, 10 mCi, with white I labels. Subject package was first noted on July 30, 1980, at Flying Tigers.

5. A meeting was held at the Atlanta Airport on August 22, 1980 to resolve reporting and alert notification procedures of RAM incidents occurring on Airport property. Alerting difficulties for the incident of August 12 caused much concern.

6. During August, all RAM carriers, forwarders, passenger and cargo airlines, fire departments, Civil Defense, Atlanta Airport Operations and interstate RAM carriers were furnished a booklet "Radiation Emergency Information," published by Georgia Department of Natural Resources, Environmental Protection Division, Environmental Radiation Program, dated July 1980. Booklet provides telephone directory for emergency Georgia radiological assistance as well as a list of immediate actions to be taken in the event of a radiation accident.

DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
WASHINGTON, D.C. 20590

DOT-E 8308

1. New England Nuclear Corporation, Boston, Massachusetts, is hereby granted an exemption from those provisions of this Department's Hazardous Materials Regulations specified in paragraph 5 below to transport packages of radioactive materials in commerce subject to the limitations and special requirements specified herein. This exemption authorizes the carriage of radioactive materials aboard highway vehicles when the combined transport index exceeds 50 and/or the separation criteria can not be met, and provides no relief from any regulation other than as specifically stated. Each of the following is hereby granted the status of a party to this exemption:

Sky Cab, Inc., East Brunswick, New Jersey - PTE-1.

2. Basis. This exemption is based on New England Nuclear Corporation's application dated October 4, 1979, submitted in accordance with 49 CFR 107.103 and the public proceeding thereon. The granting of party status is based on the following applications submitted in accordance with 49 CFR 107.111 and the public proceeding thereon:

Sky Cab, Inc.'s application dated October 15, 1979.

3. HAZARDOUS MATERIALS (Descriptor and class). Radioactive materials.

4. PROPER SHIPPING NAME (49 CFR 172.101). Radioactive Material, NOS.

5. REGULATION AFFECTED. 49 CFR 177.842(a) and right hand column of table in 49 CFR 177.842(b).

6. MODE OF TRANSPORTATION AUTHORIZED. Closed transport vehicles by highway.

7. SAFETY CONTROL MEASURES. The carriage of radioactive materials in highway vehicle operations, without compliance with the Transport Index limitations cited in paragraph 5 above, is authorized provided the carriers as identified above:

a. Limit to 50 the total Transport Index of all radioactive materials packages carried in one vehicle, except that the Transport Index of those packages containing devices commonly known as Molybdenum-99 generators shall not be included in the total.

b. Maintain a radiation protection program that will assure compliance with the standards set forth in the regulations of the Occupational Safety and Health Administration for employees who work in restricted areas where individuals may be exposed to radiation (29 CFR 1910.96, excluding 1910.96(b)(2)). All personnel operating vehicles or loading and unloading the vehicles or otherwise handling the radioactive materials packages under the provisions of this exemption are considered to be in restricted areas and must wear radiation monitoring devices.

c. Make every reasonable effort to maintain radiation exposures as far below the limits set forth in 29 CFR 1910.96 as practicable.

d. Have available the services of a competent health physicist to supervise the carrier's radiation protection program. This person shall have a Bachelor's degree in a science or engineering subject, or its equivalent, and at least six years of responsible professional experience in health physics, at least three of which have been in applied radiation protection work, specifically including experience in the kinds of radiation protection problems likely to arise in the carrier's operation. This person shall be assigned the responsibility for carrying out condition 7c of this exemption and shall be required to make it a formal part of the radiation protection program.

e. Conduct radiation surveys after vehicle loading and before departure for operations under this exemption to assure that radiation levels are less than the limits of 49 CFR 173.393(j)(2),(3), and (4). Conduct contamination surveys of the inside of the vehicle after any abnormal occurance or condition that might result in contamination or suspected contamination and prior to its use of the vehicle for transport of any other cargo, to assure that there is no significant removable radioactive surface contamination, as defined in 49 CFR 173.397.

f. Obtain written assurance from the shipper that each package which the shipper offers to the carrier for transport contains no fissile material.

g. Assess personnel radiation exposures on a monthly basis. On a quarterly basis, the health physicist shall analyze the effectiveness of prior and current efforts required by paragraphs 7b and 7c, and determine what additional efforts will be taken. A report of this analysis and determination along with the results of the vehicle radiation level surveys and contamination surveys and records kept in accordance with 29 CFR 1910.96 must be submitted quarterly to the Materials Transportation Bureau, DMT-12, within 30 days after the end of each calendar quarter.

8. SPECIAL PROVISIONS.

a. A copy of this exemption and of Title 29 CFR 1910.96 must be posted in work places such as terminals or points of origin of operations under this exemption and must be carried with the shipping papers in any vehicle used to transport packages covered by this exemption,

b. The carrier shall assure that as a result of operations under this exemption no connecting carrier transports radioactive materials packages so as to exceed an absolute (including the molybdenum generators) Transport Index total of 50 per vehicle, unless that carrier is party to this or other authorizing exemption.

c. In each vehicle with the shipping papers there must be a copy of the vehicle survey (first sentence paragraph 7e) and emergency instructions for the operator and suggested instructions for emergency service personnel to follow in the event of an incident that incapacitates the operator. These instructions and procedures shall include notification of required Federal or State authorities in addition to the officials of the carrier's organization. Included shall be a listing of Federal and State authorities and their phone numbers for all States in which operations are conducted under this exemption.

d. Cargo, other than fissile radioactive materials, may be carried under the provisions of this exemption, provided it is not otherwise prohibited by the regulations.

9. REPORTING REQUIREMENTS. Any incident involving loss of contents of the package must be reported to the Office of Hazardous Materials Regulation (OHMR) as soon as practicable. The notification requirements of 29 CFR 1910.96 shall be reported to the OHMR in lieu of the Assistant Secretary of Labor. Routine reports are required by paragraph 7g.

10. EXPIRATION DATE. February 15, 1981.

Issued at Washington, D.C.

MAR 17 1980
(DATE)

Alan I. Roberts
Associate Director for
Hazardous Materials Regulation
Materials Transportation Bureau

Address all inquires to: Associate Director for Hazardous Materials Regulation, Materials Transportation Bureau, Research and Special Programs Administration, U.S. Department of Transportation, Washington, D.C., 20590. Attention: Exemptions Branch.

Dist: B of E, FHWA

NUREG/CR-2280

Transportation of Radioactive Material in Georgia

October 1979 - September 1980

Prepared by *M. W. Carter, J. T. Gasper, B. Kahn

Georgia Institute of Technology

Georgia Department of Human Resources

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TRANSPORTATION OF RADIOACTIVE MATERIAL IN GEORGIA

(Third Year of Study)

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NRC FIN B1612

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ABSTRACT

The results of a 3-year study of radioactive materials transportation in Georgia are presented and detailed information is given for the third year of the study. The study considered the magnitude of radioactive materials shipments in terms of numbers of packages and motor vehicle trips and types of materials; compliance with regulations for packaging, labelling, handling, external radiation exposure, and surface contamination; and dose to workers as measured with personnel dosimeters. Much of the information was obtained at the Atlanta airport and its vicinity, a package distribution center for the southeastern U.S., and at the Barnwell, S.C. radioactive waste burial site, the destination of most shipments of radioactive waste from or through Georgia.

Approximately 12,000 packages in radioactive material categories I, II, and III were handled in Georgia each year. Motor vehicles made approximately 3,300 trips per year. Some instances of noncompliance were observed, but few of them had the potential for elevated radiation exposure of persons. Several incidents associated with radioactive material transport are reported, of which one may have resulted in slightly elevated exposures to persons. Among drivers and handlers who worked with radioactive material shipments, dosimeters showed that less than one-half of them received radiation doses above background levels. The highest doses were found for drivers who carried large numbers of Mo-99 generators. It is recommended that further consideration be given to controlling exclusive use vehicles and overpacks, and that health physics efforts be expanded for workers who may be exposed to elevated radiation levels from radioactive materials.

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ACKNOWLEDGMENTS

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INTRODUCTION

The number of radioactive material packages transported in the United States exceeded 2,500,000 in 1975 (Gr 76)*. Although this amount constitutes only a small fraction of all shipments or even of packages in the hazardous materials category, it includes so much radioactivity in so many forms that these shipments are worthy of extensive radiation protection considerations. Federal agencies and their State counterparts control radiation exposure to transportation workers and the public by specifying packaging, labelling, and handling procedures, and by limiting radionuclide amounts, external radiation doses, and surface contamination. The Federal agencies also maintain inspection programs and support surveillance studies to determine the extent of radioactive materials shipments, compliance with regulations, and radiation exposure to persons (LA 78). The results obtained in a 3-year-long study in Georgia are summarized here, and detailed data are presented from the third year of the study.

Transportation of radioactive materials is regulated by the U.S. Department of Transportation (DOT) and the U.S. Nuclear Regulatory Commission (NRC) in 49 CFR Parts 171 - 178. Among the most important regulations to be considered in monitoring compliance for the usual shipments of radioactive materials are the requirements for information in shipping papers and on package labels, affixing warning placards to every side of a motor vehicle, and limiting the potential radiation exposure in terms of label categories and the transportation index (TI). The TI is defined as the highest dose rate, in mrem/hr, at a 3-foot distance from the package. The label categories permit the following maximum dose rates:

Yellow III	- 200	mrem/hr at surface and TI of 10
Yellow II	- 50	mrem/hr at surface and TI of 1
White I	- 0.5	mrem/hr at surface

Specified radionuclides and amounts that result in lower surface dose rates than the White I category are described as Limited Quantities (Ltd) and do not require radiation warning labels on the outside of the package. The total TI per motor vehicle or storage location is limited to 50, and minimum distances to the nearest film package, person, or cargo compartment divider are given as function of TI in 49 CFR Part 177.842. An exception is made for "exclusive use" vehicles to permit maxima of 1,000 TI per package, 200 mrem/hr at the external surface, 10 mrem/hr 6' from the surface, and 2 mrem/hr at a normally occupied position in the vehicle. The maximum surface contamination permitted for most radionuclides that emit beta particles and gamma rays is 100 picocurie/square centimeters (pCi/cm^2).

Surveillance studies have been reported by a number of state agencies (LA 78, Pe 78, SC 78, Il 81, Mi 80). Some of these studies are still

*See References on pages 30-31

continuing, and additional ones have been begun in Kentucky, Florida, Washington, and Nevada. Of particular interest are observations of the radiation exposure to workers at major airports (Sh 76, Lu 78); studies near waste burial facilities in South Carolina (SC 78), Washington, and Nevada; and a test of using sensitive radiation detectors in highway police cars to monitor radiation doses from vehicles on highways (Il 80). Generic impact evaluations have estimated the magnitude and pattern of radioactive material shipments, doses to workers and the population, and the frequency and seriousness of accidents (DR 72, Sm 76, OS 77). A series of symposia on packaging and transporting radioactive materials has provided information on the reliability of packages and occasions of incidents and accidents (Sa 78). The data from a reporting program for hazardous materials transportation accidents have been reported for the years 1971-1975 (Gr 76).

The results of the study in Georgia are presented to report the radiation exposure levels and problems associated with radioactive material shipments in this area and to contribute information for generic considerations. This state, in common with others, has widespread use of radiopharmaceuticals and teletherapy sources by hospitals, use of radiography sources for structural inspections, and shipments of radioactive waste from various facilities. In addition, radioactive materials are shipped through the state to and from nuclear power plants in Georgia, Florida and Alabama; a research reactor in Atlanta and a national laboratory in east Tennessee; and seaports in Georgia, Florida and South Carolina. The Atlanta airport is a center for shipping packages by air to and from the southeastern US, and radioactive wastes from many other states are carried by truck through Georgia to the Barnwell, SC, radioactive waste burial facility.

The study consisted of three parts: determining the number and type of shipments, monitoring for compliance, and measuring radiation exposures for extended periods. For the first part, radioactive material carriers were found through a survey assisted by regulatory agencies. Records of shipments were obtained from the carriers and from some shippers and consignees, and additional information was collected during monitoring trips. Shipments were categorized as radiopharmaceuticals; radionuclides for industry, research or education; radiation sources for medicine (teletherapy) or industry (radiography); nuclear fuel cycle materials; and radioactive waste from these uses. Packages, vehicles and handling practices were monitored for compliance with regulations, external radiation exposure rates near packages were measured with survey instruments, and surface contamination of packages and vehicles was determined by measuring radioactivity on smears. Thermoluminescent dosimeters (TLDs) were issued to workers and placed at drivers' seats and on terminal walls to measure long-term radiation exposures. In accord with the pattern of radioactive materials shipments in Georgia, most efforts were devoted to the Atlanta area. Shipments of radioactive materials by Federal agencies were not included in the study. Additional detailed records of this study are available in preceding annual progress reports (Ca 79, Ca 81).

PROCEDURE

Information was collected from the following organizations that handled radioactive materials shipments: 5 airlines and 10 airfreight carriers at the Atlanta Hartsfield Airport, the ground forwarder near the airport that distributed most radioactive materials packages in Georgia and the 3 interstate carriers that delivered radiopharmaceuticals to the ground forwarder, 8 other interstate motor vehicle carriers and 1 railroad, the operator of the Barnwell waste facility and the Georgia Tech Nuclear Reactor Center, and Federal and State agencies that had been notified about shipments. Other carriers were questioned periodically to assure that they handled few or no radioactive materials shipments. The carriers contacted in the third year of the study are listed in Appendix A.

Information concerning the radionuclide and its amount, the TI value, and the label category were obtained from radioactive material logs, bills of lading, pilot notifications for restricted articles, burial records at the Barnwell facility, and observation during monitoring surveys. Package data are summarized only for Categories I, II, and III; information on Ltd. packages was collected, but is incomplete because it reflects only some shipments recognized by supplier or contents.

Radioactive materials packages and transport practices were monitored approximately once every four weeks on the weekend and one day during midweek. Ionization chamber survey meters that had been calibrated with Ra-226 standard sources were used for radiation measurements. Although the readings with survey meters (and also with TLDs, as discussed below) were in milliroentgen per hour (mR/hr), the observed values were compared directly to the limits given in mrem/hr, consistent with general practice in monitoring radioactive materials shipments (OS 79). Vehicle and package surfaces were smeared with cloth wipes that were then measured for radioactivity in the laboratory with beta-particle detectors and Ge(Li) gamma-ray spectrometers. Compliance with regulations was checked for package integrity, label placement and contents, consistency and completeness of shipping papers, package placement at terminals and in vehicles, and placarding of vehicles. All monitoring was performed with the permission of facility supervisors, and efforts were made to interfere as little as possible with normal operations. Radiation exposure problems were brought to the attention of supervisors and, where necessary, of workers and regulatory agency staff.

In responding to accidents and monitoring vehicles that could only be intercepted in transit, the work was done with officials from the Georgia Departments of Human Resources (DHR) and Natural Resources (DNR). Notification of accidents and of shipments of large amounts of radionuclides came from these agencies. To monitor a shipment in transit, arrangements were made with the carrier to meet the truck enroute.

Radiation dose rates were measured as a function of number and configuration of Mo-99 generator packages at various distances to relate dose rates to TI values. Generators from three radiopharmaceutical suppliers were stacked on a wooden dolly 31 inches above a concrete floor in a large terminal, and the radiation exposure rate was measured on a line perpendicular to the plane of the stacked generators and through the midpoint of the middle generator, beginning at the surface and going to a distance 16' from the surface. The generators were measured singly, then side by side and stacked in several rows all in one plane, and finally in two planes, one behind the other. Generators that had the same TI value from the same supplier were selected, and the TI value of each generator was measured separately. The measured exposure rates per TI were compared as a function of distance in terms of the inverse square law.

Radiation exposures of transportation workers were measured with TLDs issued to them on either monthly or quarterly schedules. The TLDs were LiF chips, 0.12"x0.12"x0.035", placed in black plastic sleeves within a clear plastic container, 0.01" thick. The TLDs were calibrated with a Ra-226 standard source. The dosimeters were issued to those workers who were expected to be exposed to the highest radiation levels at the ground forwarder terminal, two airline freight terminals, and two air cargo terminals. The workers at the ground forwarder terminal included motor vehicle drivers for the ground forwarder and for interstate carriers that deliver radiopharmaceuticals to the terminal. Dosimeters were also issued to some office workers considered to be controls. It was recommended that the TLDs be carried in workers' wallets. In some instances, workers kept the dosimeters for extended periods before they could be collected for reading. Some workers were removed from the sampling group because they did not cooperate or were considered unreliable.

Dosimeters were also placed at the backs of drivers' seats and on the walls of terminals near where elevated radiation levels were believed to occur, to check on the personnel exposure results. These TLDs were collected at 3-month intervals for reading. Some TLDs were also mounted at control locations at terminals.

RESULTS AND DISCUSSION

Magnitude of Radioactive Material Shipments

Most of the radioactive material packages contained radiopharmaceuticals. The pattern of shipments was set by Mo-99 generators of Tc-99m. These were by far the most prevalent radiopharmaceuticals in terms of number of packages, curies and TI. Because the 66-hour half life of Mo-99 requires prompt use, a system of delivery on weekends and use in hospitals early in the week had developed. The second radionuclide in number of packages was I-131; other radionuclides recurrently observed were H-3, C-14, Cr-51, Co-57, Ga-67, Se-75, Y-90, In-111, I-123, I-125, Xe-133, Yb-169, and Tl-201.

Most radiopharmaceutical packages were brought to Atlanta by exclusive-use truck or chartered airplane between Friday night and Sunday morning, and distributed on Sunday and early Monday morning from Atlanta in approximately 30 ground forwarder vans and trucks to hospitals throughout Georgia and neighboring states. These arrangements changed periodically, as shown in Table 1. At the end of the study (see Appendix B-1), interstate carrier trucks were delivering these radiopharmaceuticals from Boston, MA, New Brunswick, NJ, and St. Louis, MO. Approximately 200 packages in Categories I, II and III were transferred at the ground forwarder terminal for distribution, one-half in Georgia, and the rest in Alabama, north Florida and southeast Tennessee. Some packages were transferred among these trucks, to a van to Alabama, and to a chartered plane to New Orleans, LA. Packages that remained on the trucks for delivery to Florida and North Carolina were not counted. The number of packages for Georgia remained almost constant during the 3 years of study. The number transferred here for neighboring states varied with the pattern of distribution, and had decreased by the end of the study because more packages were shipped directly to these states.

A few radiopharmaceutical packages were delivered to Atlanta airport by passenger airlines, as shown in Table 2 for two 1-year periods and detailed for the third year in Appendices B-2 to B-5. These packages were usually picked up within minutes to hours by a ground forwarder or airfreight van and taken to the ground forwarder terminal for distribution. Some of the packages listed in Table 2 were delivered on the weekend and are included in Table 1 (notably the packages from supplier AM). Others were delivered during the week and may have increased the totals of Table 1 by possibly 10 per week. Table 2 also includes information concerning radiopharmaceutical packages that were transferred between passenger flights or from passenger flights to an air cargo carrier, but does not include any packages that remained on the airplane during a stopover in Atlanta.

A number of packages of radionuclides for industrial, research or educational use in Georgia or nearby states were shipped by air to the Atlanta airport and then by truck to the consignee. The transport

Table 1

Radiopharmaceutical Shipments by Truck or Chartered Flight to Georgia on Weekends, 1978-1980

Shipper	Date	Radionuclides, packages/week I-131	Mo-99	Other	Activity, Ci/week	TI per week	Category, packages/week I	II	III	Total packages per week
Trucks or chartered flight through ground forwarder terminal at Atlanta to GA, FL, AL, TN, NC and SC										
MA	Oct 78 - Mar 79	34.5	95.7	4.0	104.3	108.3	0.5	29.2	102.7	132.4
	Apr 79 - Sept 80	16.6	19.9	4.4	25.5	41.1	0	16.3	22.2	38.5
NE	Oct 78 - Sept 80	0.09	27.9	41.8	33.8	101.0	25.4	9.9	29.8	65.1
SQ	Oct 78 - Dec 79	9.7	43.7	5.7	69.4	105.7	0.06	6.4	49.7	56.2
	Feb 80 - Sept 80	1.6	21.6	1.6	29.4	85.5	0	2.4	22.0	24.4
AM*	Apr 79	0	0	3.	0.011	0.3	1	2	0	3
Truck through sub-contractor to GA (Atlanta and Columbus) and AL										
SQ	Feb 80 - Sept 80	3	39.3	1.3	56.8	151	0	3.7	39.7	43.4
Truck to Atlanta Charlie Brown Airport for chartered flight to LA and MS										
NE	Jun 80 - Sept 80	unk	25	unk	unk	85.5	unk	unk	25	25
Truck to Atlanta										
NE	Jun 80 - Sept 80	unk	1	unk	unk	9	unk	unk	1	1
Truck through Athens and Waycross, GA, from Charlotte, NC to FL										
MA	Apr 80 - Sept 80	1.1	1	0.4	1.0	1.4	0	1.4	1	2.4

* by passenger airline

Table 2

Average Weekly Radioactive Material Shipments by Air at Atlanta Airport

Radioactive Material	Direction	Year	No. of Carriers	Activity, Ci	TI	Category, packages/week I	II	III	Total packages per week
Radiopharmaceutical	Terminating	1979	2	10	14	0.7	0.9	13	15
		1980	2	8.9	13	1.4	8.5	7.1	17
	Outbound	1979	4	201	23	1.8	2.2	7.4	11
		1980	4	1.8	7.8	13	10.3	2.8	26
Industrial/Research/ Educational	Terminating	1979	2	19	0.5	0	1.1	0.15	1.2
		1980	2	14	0.3	0	0	0.14	0.14
	Outbound	1979	4	13,100	1.6	1.4	2.8	0.3	4.5
		1980	4	12,000	2.3	2.0	0.9	1.7	4.6

Notes: 1. Information was obtained for periods of 1-5 months.

2. The amount of 201 Ci outbound in 1979 resulted from rerouting large amounts of Mo-99 to source suppliers through Atlanta airport during a strike on one airline.

pattern was reversed if the supplier was in or near Georgia and the consignee was at a distance. As shown by the data for airfreight carriers in Table 2 and Appendices B-6 to B-9, the number of these packages was very small compared to radiopharmaceuticals. The curie totals are much higher, however, because some packages contained thousands of curies of radionuclides such as H-3 (Ca 79, Ca 81).

The values in Table 2 somewhat underestimate the weekly totals because records were not available from one major airline carrier and one air cargo service. Some data for the latter carrier are included, however, because a shipper (Appendix B-10) and several consignees (Appendix B-11) provided records. From observations during monitoring, an additional 20 radiopharmaceutical packages (terminating) and 1 industrial package (outbound) were estimated to be handled at Atlanta airport each week.

Among the radioactive materials transported by airfreight carriers were packages of Ir-192 for industrial radiography. Large amounts -- as many as 8,000 Ci per package -- were sent from the Oak Ridge National Laboratory through Atlanta airport to source suppliers in nearby states. These suppliers shipped sources that typically contained 100 Ci each to industrial radiographers in Georgia. During 1980, 24 radiographers were licensed in Georgia and approximately an equal number practiced in Georgia under reciprocal licensing agreements with other states. Sources from four suppliers were observed. Because Ir-192 has a 74-day half life, these sources are returned to the supplier after about 6 months. Records of shipments for two radiographers during the third year of study are given in Appendix B-11. Radiographers transport source-containing cameras by van or truck to and from the construction or test sites where the sources are used.

In 1978, 22 Co-60 teletherapy sources and 2 Cs-137 sources were licensed in Georgia. The Co-60 sources ranged from 5,000 to 11,000 Ci and the Cs-137 sources were 2,000 Ci each. New and used sources are transported by truck in special containers to and from out-of-state suppliers. Shipments are relatively infrequent due to the 5.3-year half life of Co-60 and the 30-year half life of Cs-137. State DHR officials were notified of 3 shipments in the first year of study to arrange for monitoring at hospitals (Ca 79).

Radioactive materials that were shipped in connection with the development and application of the nuclear fuel cycle included thorium-bearing ore for refining, uranium hexafluoride gas for conversion to uranium dioxide, spent fuel elements for testing, and contaminated clothing for laundering. Thorium minerals were transported generally from the port of Charleston, SC to Chattanooga, TN by railroad; in an 18-month period (July 1976 - December 1977), 119 carloads were shipped on 19 occasions (Ca 79). During the same period, the railroad carried 42 loads of uranium hexafluoride through the state on 7 occasions to and from gaseous diffusion plants in Oak Ridge, TN and Paducah, KY; this

material occasionally was also shipped by truck. Contaminated clothing was shipped by truck to a laundry in Macon, GA and returned after cleaning. Approximately 100 shipments, constituting 2,000 drums, were reported in 1977 (Ca 79).

The largest curie amounts were transported in spent fuel elements. During the 3-year period, 20 shipments were carried by truck through Georgia from nuclear power plants. The fission product activity ranged from 130,000 to 800,000 Ci per shipment. Shielding by the special containers kept the highest TI value to 12, and the highest exposure rate at a distance of 6' to 1.2 mR/hr. All shipments were reported to State DHR officials, and selected trucks were monitored in transit.

The most frequent shipments from nuclear power stations were radioactive wastes for burial at the Barnwell, SC site. Records for 4 months in 1979 shown in Table 3 indicate 80 shipments per month from 10 shippers. Most shipments were from six nuclear power plants -- one in Georgia, two in Alabama, and three in Florida. Waste was also sent from plants in Michigan, Illinois, Iowa, Arkansas, Minnesota, and Wisconsin (Ca 81) because all other waste burial sites east of the Mississippi had been closed. The interstate route through Georgia to Barnwell, SC is an alternate to routes through North Carolina, hence only some of the shipments from the midwest passed through Georgia.

Radioactive wastes from hospitals, industries, and schools are also sent to Barnwell, to the extent indicated in the second data line of Table 3. Shipments from Atlanta-area schools are given in Appendix B-12. The shipments were generally fewer and the activity was lower than for wastes from nuclear power stations.

Regulations under the Georgia Transportation of Hazardous Materials Act (No. 487, 1979) require permits for transporting defined types and amounts of radioactive materials on highways, and notification of the Georgia Department of Transportation before and after the shipment in the state. The last data line in Table 3 indicates the average monthly shipments reported in two months during 1979. Details are given in Appendix B-13. Because all of the waste shipments indicated in the upper part of the Table should have been reported to the state and no decrease in number of shipments from 1979 to 1980 had been observed, reporting apparently was incomplete. Moreover, none of the radiopharmaceutical shipments listed in Table 1 had been reported.

On the basis of the presented data and estimates, approximately 230 radiopharmaceutical packages and 6 industrial packages of radioactive materials in Categories I, II, and III were handled in Georgia each week. Additional packages passed through the state in trucks and airplanes. These packages handled in the state total 12,000 and 300 per year respectively, 1.3 and 0.14 percent of the 910,000 radiopharmaceutical and 220,000 industrial packages per year that were estimated for the entire United States in 1975 (Ta 78).

Table 3

Average Monthly Radioactive Waste Shipments by Truck through Georgia to Barnwell, SC

Origin	No. of Shippers	No. of States	No. of Carriers	No. of Shipments	Activity, Ci
Burial records, May 1 - August 31, 1979					
Nuclear power stations	10	6	5	80	1,350
Other facilities	9	7	11	17	9
Transport notification to Georgia Department of Transportation, August 1 - September 30, 1980					
All facilities	--	4	6	61	--

Note: Two additional shipments from "Other facilities" consisted of two sealed 43,000-Ci Cs-137 sources.

An analysis of responses by shippers in 1975 concerning radioactive materials shipped to, from, and across the Atlanta "standard metropolitan statistical area" (one of 20 thus considered) yielded 26,000 shipments per year, containing 240,000 Ci at a total TI of 23,000 (He 81). The shipments were reported to be distributed approximately equally among air freight, passenger airlines, trucks and ships as carriers, with only a minor contribution by rail and private auto. The inclusion of 8,000 shipments across Atlanta by air, and of ships as carriers in another 8,000 shipments, accounts for totals that were much larger than reported here.

The motor vehicles that transported radioactive packages each week consisted of 4 interstate carriers of radiopharmaceuticals, 30 ground forwarder vans, and 6 trucks to take the industrial radioactive materials to and from the airport, totalling 2,100 trips per year. The 97 monthly shipments of radioactive waste reported in Table 3 add 1,200 trips per year. Only a few shipments per year of teletherapy sources and spent fuel elements were encountered. Among railroads, one line reported 21 shipments per year during the first year of study and a second one reported none (Ca 79). Transport of radioactive materials by ship and barge was not monitored, although it was observed that some motor vehicle and rail shipments came from or were destined for ports of entry.

Surveys of Radioactive Material Shipments

Of more than 700 packages monitored during the 3-year period, very few were found to have the potential for causing elevated radiation exposure or radionuclide contamination. Surveys were based on the items considered for monitoring by the NRC and DOT (LA 78) shown in Table 4. The detailed observations for the third year of the study are given in Appendix C-1. In the instances of TI values exceeding the values recorded on the label, the greatest excess among 11 packages was 1.3. The occurrences noted in Table 4 of TI values greater than 50 per pile and, simultaneously, insufficient distances from piles to photographic film resulted from stacking radiopharmaceutical packages according to routes at the ground forwarder terminal.

The average exposure rates in the cab and at a distance of 6' from the sides of vehicles that carried radiopharmaceuticals, checked on approximately 300 occasions, were approximately 4 mR/hr, as shown in Table 5. The maximum was as high as 50 mR/hr in the cab. The regulations that are intended to limit the dose rate at the driver's seat by requiring specified package separation distances in ordinary carrier vehicles and a maximum dose rate of 2 mrem/hr in exclusive-use vehicles were violated on four vehicle routes for the number of instances given in Table 5. The elevated radiation exposure levels are attributed to excessive TI or to improper package placement in the vehicle, in some instances because the vehicle was too small. On a few occasions, radioactive material placards were not displayed on all sides of the vehicle. Some shipping documents were not appropriate because a load described on one freight bill was split among two vehicles or because

Table 4

Package Monitoring Observations

	Item	No. of Occurrences (No. of Observations) 1977-1978	1978-1979	1979-1980
1	No label	0 (380)	0 (230)	1 (126)
2	Wrong label	3 (380)	0 (230)	2 (126)
3	One label covered or missing	0 (327)	2 (214)	6 (126)
4	TI observed > TI label by more than 0.5	7 (256)	2 (209)	2 (103)
5	TI not recorded	1 (256)	3 (209)	1 (103)
6	Security seal broken	0 (380)	1 (230)	0 (126)
7	No or improper security seal	2 (380)	0 (230)	2 (126)
8	Package authority covered or not listed	6 (327)	2 (214)	3 (126)
9	Surface dose rate > yellow II or III limit	0 (256)	0 (209)	0 (103)
10	Nonspecification packages	0 (380)	0 (230)	0 (130)
11	Detectable or removable contamination	1 (348)	20 (224)	9 (127)
12	Removable contamination above DOT limits	0 (348)	0 (224)	0 (127)
13	Special form material not labeled as special form	1 (327)	0 (214)	1 (126)
14	Greater than 50 TI in storage	2	12	0
15	Storage separation distances less than allowed	2	12	0

Table 5

Summary of Radioactive Material Transport Vehicle Surveys

	Radiopharmaceutical	Industrial, Research and Educational	Nuclear Fuel Cycle
No. of vehicles	305	8	14
Radiation levels, mR/hr			
Cab average (maximum)	3.5 (50)	0.08 (0.1)	0.009 (0.3)
Surface average (maximum)	33 (120)	1.0 (1.3)	5.1 (9)
6-ft distant average (maximum)	4.3 (18)	0.11 (0.13)	0.9 (1.9)
TI average (maximum)	66 (350)	---	4.2 (20)
Excessive removable contamination	none	none	none
Excessive radiation levels in cab	30	none	none
Excessive TI	23	none	none
Improper package placement	33	none	NA
Improper shipping documents	13 of 249 vehicles	none	none
Insufficient placards	24 of 173 vehicles	none	1

the driver had given the wrong freightbill to the recipient of packages delivered before coming to Atlanta. Observations for the third year of the study are summarized in Appendix C-2 and detailed in Appendix C-3.

Only one violation was observed in the other monitored trucks listed in Table 5. The industrial/research/educational and nuclear fuel cycle categories each included trucks carrying radioactive waste to the Barnwell, SC burial site. These vehicles were met by prearrangement, hence compliance with regulations is not surprising. During the third year of study, NRC inspectors cited three trucks that carried radioactive waste to the Barnwell burial site for violations, as indicated in Appendix C-4.

All positive results of radioactivity on smears to determine surface contamination on packages and vehicles were below the limits of 49 CFR Part 173.397(a), as shown in Table 6 and presented in detail for the third year of the study in Appendix C-5. The common contaminating radionuclides for radiopharmaceutical packages and the vehicles that carried these packages were Se-75, Mo-99, and I-131. The prevalence of Se-75 was unexpected in view of its relatively low level of use. The detectable radionuclides on trucks that carried materials from nuclear power plants usually were Mn-54, Co-58, Co-60, Cs-134, and Cs-137.

Studies in other states (Il 80, SC 78) also observed violations, mostly related to improper shipping papers, labels or placarding. Approximately one-third of the motor vehicles examined during spot surveys on Illinois highways were issued Notices of Apparent Violation for these causes (Il 80). No excessive surface contamination was found in these studies.

During the 3-year period, the nine incidents listed in Table 7 occurred in connection with transporting radioactive material. The last of the listed incidents was discovered in the course of the study; all others were reported to DHR or DNR officials. The shipment of Mo-99 to the Chattanooga hospital on October 10, 1978 may have caused elevated radiation exposure levels to handlers and the driver of a van (Ca 81). The accident at the railroad yard on February 2, 1979, caused minor environmental contamination due to the monazite spill. No other incidents of radioactivity contamination or exposure to humans were found as results of accidents or incidents.

Radiation Exposures to Transportation Workers

Of 81 handlers and drivers working with radioactive materials whose radiation exposures were measured with dosimeters in 1978-79, and of 67 measured in the following year, more than one-half were at background levels. Annual exposures for the others ranged from just above background to 5,700 mR, as indicated in Table 8. The detailed values

Table 6

Surface Radionuclide Contamination Determined with Smears

Radionuclide	Area contamination, pCi/100 cm^2 (no. of occasions) Packages	Vehicles
H-3	0.2 (1)	--- (0)
Mn-54	--- (0)	0.08- 400 (4)
Co-57	--- (0)	0.01- 14 (8)
Co-58	--- (0)	0.6 -3,300 (4)
Co-60	0.2 (1)	0.2 -7,100 (6)
Se-75	0.01 - 0.4 (28)	0.02- 66 (24)
Mo-99	0.005 - 7.8 (29)	0.03- 1.5 (23)
I-131	0.005 - 81 (27)	0.05- 1.2 (23)
Cs-134	--- (0)	0.2 -2,400 (5)
Cs-137	--- (0)	0.2 -7,000 (6)

Notes: 1. Radioactivity was detected on packages on 30 of 700 occasions and on vehicles (trucks, vans, and chartered airplanes) on 30 of 86 occasions. Frequently, several smears were obtained per vehicle or several smears were counted together.

2. Period of observation: September 1977 - September 1980.

3. None of the above contamination levels exceeded regulatory limits.

Table 7

Radioactive Materials Shipment Incidents
(September 1977 - September 1980)

Date	Location	Occurrence
8/29/78	Wildwood, GA (I-24 near I-59)	A tractor-trailer truck carrying radioactive waste from nuclear power stations in Illinois to Barnwell, SC overturned. The cask withstood the impact and no radioactive waste was spilled. Radiological safety teams from ORNL and from Georgia and Tennessee radiological protection agencies responded. Surface radioactive contamination on the vehicle and cask was very low.
10/10/78	Atlanta (in transit to Chattanooga)	Staff at a Chattanooga hospital measured an exposure rate of 30 - 50 mR/hr 3' from a Mo-99 generator package (0.8 Ci, TI 1.6) delivered that day. Tennessee and Georgia radiological protection agency staffs were informed by the hospital. Lack of part of the lead shield apparently caused the elevated exposure rate. The TLD of the driver who had delivered the package (terminal D, route 014) was collected and read on October 16. For the 2-month exposure period since dosimeter issuance, the exposure was 60 mR, approximately 46 mR above background. The average exposure rate for the driver during this year was 28 mR for the period. Hence, part of the elevated TLD reading may have been exposure from this Mo-99 generator.
2/2/79	Tilford Yard of Family Lines Railroad, Atlanta	A flat-bed rail car derailed with two trailers that carried bags of monazite from the port of Charleston, SC, to Chattanooga, TN. The top of one trailer broke open and spilled monazite over the immediate area; the other trailer was deformed from the shifting load but retained the monazite. The 50-kg bags of monazite loaded on pallets in the trailers had II labels; the trailers had III labels showing natural thorium, 0.126 Ci, TI 7. Exposure rates measured outside the trailers were as high as 13 mR/hr at the surfaces and 5 mR/hr at 3'. The unopened trailer and the unopened bags in the broken trailer were sent to their destination. Spilled monazite and contaminated soil were collected in drums by a contractor for the railroad and stored in Atlanta, where they remain. Only a small residue of monazite was found on the ground after decontamination.
8/4/79	Eastern Airlines Cargo Terminal, Atlanta	A package of Co-57 was crushed. Georgia DNR staff observed that the contents of the package -- 3 bottles and 4 vials -- remained unbroken. The vials were repacked.

Table 7 (cont'd)

Date	Location	Occurrence
10/22/79	Albany, GA	A truck with a shipment of radioactive waste from the Farley (AL) Nuclear Power Plant to Barnwell, SC was involved in a minor traffic accident. The radioactive waste cask was not damaged.
11/27/79	Atlanta (in transit to Barnwell, SC)	Monitoring of a waste shipment from Atlanta, GA to Barnwell, SC, at the burial site showed some contamination inside the trailer. One of the legs of a contaminated two-ton shield had punctured the shipping crate during the shipment. The contamination was removed and the trailer was returned to service.
11/29/79	North Cargo Terminal, Atlanta	A package containing 12 mCi H-3 and 0.1 mCi C-14 with I labels was crushed by a forklift. The vials inside the package remained intact. No contamination was found. Vials were repackaged for shipment.
8/12/80	North Cargo Terminal, Atlanta	A pallet of nine Mo-99 generators being transferred from the aircraft to a loading dolly jumped the pin retaining stop and the Mo-99 packages fell to the ground. One cardboard box opened, exposing the plastic generator case. Radiation exposure measurements and smears of the apron and packages showed that no radioactive materials were released. The box was repackaged and sent on.
9/22/80	Atlanta (in transit to Alabaster, AL)	A shipment consisting of 3 boxes was misrouted to Nashville, TN, before arriving at Atlanta on September 18. Shipper's certificates accounted for the two I-131 packages; the third box was labelled "medical supplies, not radioactive, no labels required," but had a reading of 12 mR/hr at the surface and 0.6 mR/hr at 3'. A hospital in Alabaster, AL received this package and was notified of the elevated reading on September 22. The box contained I-131. The shipper was notified.

Table 8

Worker Radiation Exposures

Category	No. of Persons	Total period, person-weeks	Range of exposure rates avg. mR/week	Range of exposure rates calc. mR/year
1978-1979				
Controls	3	95	1.3- 1.6	68- 83
At background	41	1,297	0.9- 2.0	47- 100
<500 mrem/year above background	30	1,001	2.1- 7.9	110- 410
>500 mrem/yr above background	10	199	12 -109	620-5,700
1979-1980				
Controls	2	87	1.1- 1.3	57- 67
At background	41	1,738	0.9- 1.9	46- 96
<500 mrem/yr above background	11	459	2.1- 5.9	107- 310
>500 mrem/yr above background	15	451	13 - 93	660-4,800

Notes:
1. Measurements were obtained for 14 four-week periods in 1978-1979 and for 3 three-month periods in 1979-1980; values include natural background radiation exposure.
2. Controls were office workers at terminals.
3. Gross exposure rates between 100 and 550 mR/year were placed in the "<500 mrem/year above background" category.

for the third year of study are given in Appendices D-1 to D-9. During the last year of the study, the 15 workers who were exposed to 500 - 5,000 mrem/year all drove interstate carrier routes, while those in the 100 - 500 mrem/yr group were drivers, sorters, and supervisors at the ground forwarder terminal. In the preceding year, the workers in the highest exposure category included seven drivers of interstate trucks, two drivers of vans on local routes, and one sorter at the ground forwarder terminal. Those who were exposed to levels that could not be distinguished from background radiation worked at the airline or airfreight cargo terminals, and handled minor amounts of radioactive materials at the ground forwarder terminal or in vans dispatched from that terminal.

The data sets for the two years given in Table 8 are not directly comparable because only seven drivers of interstate trucks could be given dosimeters in 1978-79, while all fifteen drivers wore them in 1979-80. On the other hand, some of the handlers who were found to be exposed only to negligible radiation doses in the earlier period were not continued in the study during the last period. Among those in the study for both years, the numbers of handlers and local route drivers decreased from 3 to 0 in the highest exposure category and from 30 to 11 in the intermediate category.

That all of the drivers of interstate trucks or vans were in the relatively high dose rate category can be attributed to the length of time spent driving trucks loaded with radioactive materials and to loading and unloading numerous packages. For example, driving for 10 hours while exposed to 2 mR/hr at the driver's seat leads to an exposure of 20 mR; loading and unloading for 0.5 hour while carying packages of 2 TI that have an exposure rate at contact of 20 mR/TI adds 20 mR. A weekly trip for 50 weeks under this regime results in an exposure of 2,000 mR. All workers in the highest dose category drove exclusive use vehicles. Each driver carried large TI values on only one trip per week in Georgia, but drivers for interstate carriers may have transported similar cargo on other routes that added to the exposure read on their dosimeters. The drivers for interstate carriers had been issued dosimeters by the shipper or carrier in addition to the dosimeters distributed in this study.

Earlier studies of radiation exposures to handlers at airports had shown that the radiation dose was only of the order of 0.05 mrem/TI per worker and 0.2 mrem/TI total (Sh 77). At the St. Louis airport, where a supplier ships numerous Mo-99 generators every weekend, the average contact exposure was 13 mR/shift for 317 TI, and the exposure per handler was between 0 and 5 mR per shift; exposures to handlers was estimated to be between 140 and 440 mR per year (Lu 78). At these rates and the small weekly TI values shown in Table 2, it is understandable why the exposures measured for workers at the Atlanta airport were at background levels.

The workers with elevated exposures either drove vans that were relatively heavily loaded with Mo-99 generators or worked at a terminal

where most of these generators were unloaded, stored for periods of several minutes to 1.5 days, and then loaded for distribution. For workers at background radiation levels, no distinction can be made between zero and as much as 40 mR/year from radioactive materials. The uncertainty is due to the relatively wide range in the natural radiation background; from 53 to 123 mR/yr had been observed in Atlanta (Ka 79).

In applying these radiation exposure data, it should be noted that some of the measurements did not span the full year (see Appendices D-1 to D-9). Moreover, data were not included for several workers who participated too briefly to provide a consistent record and for several other workers who were not reliable in their participation (Ca 81). The latter may have refrained from wearing the dosimeters for part of their working periods or may have left the dosimeters in vehicles or near radioactive material packages. It should also be noted that the dosimeters respond to energetic beta particles and overrespond to weak gamma rays, and that they may have been shielded by the worker's body -- e.g., while sitting in the driver's seat -- for extended periods.

Measurements with TLDs at the backs of drivers' seats, summarized in Table 9 and given in detail in Appendices E-1 and E-2 for the third year of study, show that more than one-half of the 25 vehicles that had been observed to carry the largest amounts (TI) of radiopharmaceutical packages in 1980 had only background radiation exposure. Four of the five TLDs in the highest exposure category were from the four exclusive-use vehicles operated by interstate carriers; the fifth was in one of the ground-forwarder express vans that carried relatively large amounts of radiopharmaceuticals one day per week. During the previous year, TLDs could be placed in only one of the interstate carrier exclusive-use vehicles; the four other elevated TLD readings were all in ground-forwarder express vans. The exposures in ground-forwarder vehicles decreased from the first to the second period of observation due to elimination of some of the longer routes and better radioactive material handling practices.

The measurements at locations where radioactive materials were stored at terminals, summarized in Table 10 and presented in Appendix F for 1980, indicate elevated exposures at most locations, although some values at airline and airfreight cargo terminals were indistinguishable from background radiation. The indoor background levels at wall surfaces are approximately 30 percent higher on the average than the personnel and vehicle radiation background exposures. The highest exposure was below 3 R/yr, confirming that even large numbers of radioactive material packages usually did not cause high annual exposures because the materials were moved relatively rapidly.

Although these measurements at drivers' seats and terminals had been intended to check personnel exposures by comparing the times spent in

Table 9

Radiation Exposures at Drivers' Seats

Category	No. of Vehicles	Total period, vehicle-weeks	Range of exposure rates avg. mR/week	Range of exposure rates calc. mR/year
1978-1979				
At background	3	74	1.3- 1.9	65- 100
<500 mrem/yr above background	22	782	2.2- 8.5	115- 445
>500 mrem/yr above background	5	108	11.3-108	590-5,600
1979-1980				
At background	13	485	0.9- 1.9	47- 80
<500 mrem/yr above background	7	304	2.0- 3.5	109- 180
>500 mrem/yr above background	5	200	16 -119	830-5,100

Notes: 1. Measurements were obtained for 3-month periods for 13 months in 1978-1979 and 10 months in 1979-1980; some periods overlap because dosimeters were worn for more than 3 months.

2. Values include natural background radiation exposure.

3. Gross exposure rates between 100 and 550 mR/year were placed in the "<500 mrem/year above background" category.

Table 10

Radiation Exposure at Terminals, 1977-1980

Category	No. of locations	No. of quarterly periods	Range of exposure rates, mR/year
Control	13	87	61- 150
At background			
Passenger airlines	5	29	88- 110
Air cargo	9	32	74- 130
Ground forwarder	0	0	---
Above background			
Passenger airlines	8	63	190-1,680
Air cargo	8	37	160- 510
Ground forwarder	9	75	300-2,600

Note: Exposure rates were measured with TLDs for 3-month periods at cargo terminals of 2 passenger airlines, 7 air cargo carriers, and 1 ground forwarder; these values do not include two locations at one passenger airline cargo terminal where the background averaged 320 mR/year due to a concrete block wall with high radium content.

specific vehicles or at known locations, this proved impossible because of frequent changes in work assignments, vehicle assignments, and storage locations. Qualitatively, the relatively elevated radiation exposures found for the drivers of interstate carriers were consistent with the elevated exposure rates measured with TLDs at the drivers' seats and also with the surveys (see Appendix C-3) of vehicles during monitoring periods. Similarly, elevated exposures to sorters were associated with their work at the ground-forwarder terminal where elevated exposures were observed with TLDs on walls.

In response to observations of some elevated exposure rates by personnel, vehicle seat, and terminal dosimeters and by survey meter in the initial part of the study, procedures were recommended for reducing radiation exposures. Some opportunities for reducing contact time were found by rapidly loading and unloading vehicles -- although this is a common practice, and by spending as little time as possible near stored radioactive material packages. Increased separation distances could be achieved by stacking radioactive material packages as distant as was practical from terminal work areas and from vehicle drivers' seats. In some cases, larger trucks were used, or two vans instead of one, to achieve the necessary separation distance from the driver. Personnel radiation exposure decreased in response to such guidance.

The effect of distance in reducing the exposure rate per TI was tested experimentally, to assure that currently used separation distances are acceptable. The regulations for radioactive material package transportation limit radiation exposure by specifying minimum separation distances as a function of TI. The minimum distance is given as 7 feet to persons at a storage area or to cargo compartment partition for the summed TI of 50, which is the maximum for a storage location or per vehicle. Exceptions are made for exclusive-use vehicles and for overpacks. In the latter case, the TI of the overpack is used instead of the TI for the component packages.

The exposure rate as a function of TI and distance from Mo-99 generator packages of three major suppliers were measured, as shown in Table 11 and Appendix G. Even 3' from the surface, as many as 8 packages placed 1 deep in various configurations resulted in much the same exposure rate per TI as a single package. When the distance from the center of the packages to the center of the detector is taken into account, the relation of the averaged exposure rate per TI for various numbers of packages to distance follows the inverse square law, as shown in Figure 1. The three points at the upper end of the line in Figure 1 are for single packages, while all others represent the mean mR/hr per TI for each column in Appendix G.

Hence, the inverse square law is readily applicable as a rule of thumb for computing the exposure rate per TI, no matter what the configuration, as long as the packages are not shielded by other packages. Note that at the 3-foot distance (the definition of TI), the value of

Table 11

Exposure Rates from Mo-99 Generator Packages
as Function of Geometrical Configuration

No. of packages	Configuration	Exposure rate at given distance, mR/hr 0'	3'	6'	9'	12'	15'	18'
	Squibb, 2.1 ± 0.1 TI each, 12"x12"x12"							
1	-	50	2.0	0.55	0.26	0.16	0.11	-
3	side by side	73	5.1	1.7	0.78	0.46	0.30	-
4		72	7.9	2.3	1.1	0.57	0.38	-
5		84	8.8	2.6	1.3	0.76	0.47	-
6		73	9.6	3.3	1.5	0.92	0.61	-
7		88	9.6*	3.4	2.7*	1.1	0.66	0.47
8		73	11.4	4.1	2.0	1.2	0.77	0.55
2	1 x 2 high	48	3.3	1.1	0.46	0.28	0.19	-
4	2 x 2 high	54	7.5	2.1	1.1	0.56	0.37	-
6	3 x 2 high	77	9.6	3.1	1.5	0.87	0.60	-
2	1 behind other	46	2.0	0.56	0.30	0.16	0.11	-
8	4 behind 4	80	8.4	2.6	1.2	0.66	0.46	0.36
	New England Nuclear, 2.1 ± 0.1 TI each, 14.5" 14.5"x15" high							
1		43	1.8	0.54	0.25	0.15	0.10	-
3	side by side	60	5.5	1.9	1.0	0.61	0.48	0.35
5		66	8.0	2.8	1.4	0.87	0.62	0.45
6	3 x 2 high	73	9.5	3.6	1.8	1.1	0.73	0.49
8	4 x 2 high	78	13.4	4.7	2.1	1.2	0.76	0.51
10	5 x 2 high	88	14.0	5.4	3.6	1.6	1.0	0.71
9	3 x 3 high	88	14.5	4.8	2.3	1.3	0.86	0.58
10	5 behind 5	73	9.5	4.0	1.8	1.0	0.64	0.41
	Mallinckrodt, 0.9 TI, 16"x16"x17" high							
1		16.5	0.80	0.25	0.11	0.07	-	-

Notes: 1. Measurements were performed at center of configurations.
2. Two values marked with asterisk apparently were misread and were omitted from data analysis.

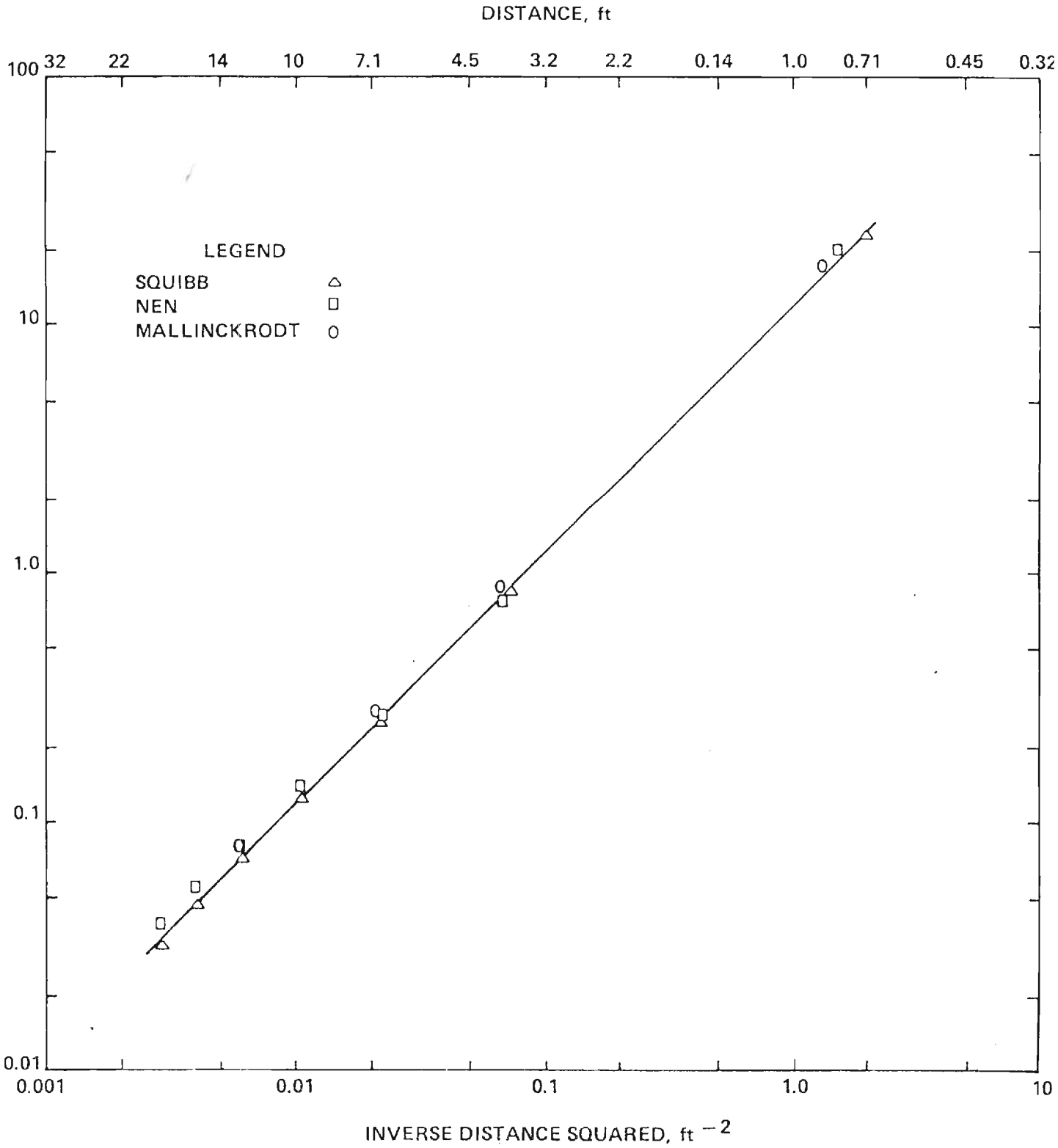

Figure 1. Exposure Rate per TI Averaged for Single and Multiple Mo-99 Generators as Function of Distance Between Midpoints of Central Generator and Detector

mR/hr per TI was approximately 15 percent below 1.0. This is because the TI is defined as the highest exposure rate measured at that distance whereas the measurements for this study were obtained by randomly placing the packages side by side or one above the other.

The importance of shielding radiation from one package by another package is shown in Table 12. The exposure rate from a second package placed behind the first was found to add only 2 percent to the exposure rate from the first. Even for multiple packages, where the front row does not shield radiation from the second row as effectively, the radiation level from doubling the TI increased only by approximately 15 percent. On this basis, a third row would add only another 2 percent. Hence, exposure rates at specified distances from the midpoint of piles of radioactive material packages can be estimated from the TI in the first two rows.

In terms of the minimum distance from radioactive material packages specified in 10 CFR Part 177.842, at a distance of 7' from a TI of 50 in one row (7.8' from the center) the exposure rate would be 0.2 mR/hr per TI in Figure 1, or 10 mR/hr. The exposure rate is reduced to 6 mR/hr if the packages are in two rows, one behind the other, and distribution among additional rows would result in progressively lower exposure rates.

Table 12

Exposure Rates from Double Rows of
Mo-99 Generator Packages

Distance, ft	Ratio of Exposure Rates, total/front		
	S (1:1)	S (4:4)	N (5:5)
0	0.92	1.11	1.11
3	1.00	1.06	1.19
6	1.02	1.13	1.43
9	1.15	1.09	1.29
12	1.00	1.16	1.15
15	1.00	1.21	1.03
18	--	--	0.91
Avg.	1.02	1.13	1.16

Notes: 1. Data from Table 11.

2. (4:4) indicates 4 generators in a row behind 4 others.
S = Squibb
N = New England Nuclear

CONCLUSIONS AND RECOMMENDATIONS

A survey conducted from 1977 to 1980 indicates that approximately 12,000 packages in radioactive materials categories I, II, and III were handled each year in Georgia for shipment by motor vehicle or combined motor vehicle and airplane. Most packages were shipped to Georgia or nearby states, but a few originated in the area and were sent to other parts of the country or to other countries. Packages shipped through Georgia without transfer in the state are not included in this number. Approximately 97 percent of these packages contained radiopharmaceuticals. The total is considerably less than one-fiftieth of the 2,500,000 packages of radioactive materials reportedly shipped in the U.S. during 1975, but the amount obtained for Georgia does not include numerous "limited quantity" packages.

The number of motor vehicle trips to transport the above-cited radiopharmaceutical and industrial/research/educational packages was approximately 2,100 per year. Another 1,200 trips per year carried radioactive materials for the nuclear fuel cycle and radioactive waste through Georgia. On a few occasions per year, motor vehicles carried teletherapy sources. Radioactive materials were also carried to and from Georgia by rail in several hundred cars, and by air in several hundred flights that land in Georgia each year.

Although items of noncompliance were found in examining the transportation of radioactive materials, few had the potential for causing elevated radiation doses to persons. Noncompliance with dose-rate limits or with minimum separation distances per TI values that are intended to limit dose rates was observed for some large shipments of Mo-99 generators, which were usually the main sources of exposure among radioactive materials shipments. Increased efforts by the regulatory agencies in inspection and worker education with regard to radioactive materials transport were noted in the course of the study, and maintenance of such efforts is recommended to minimize noncompliance. The relatively rapid turnover of handlers makes it difficult to instill the necessary awareness for minimizing radiation exposures. Furthermore, drivers for carriers are of necessity less under the scrutiny of health physicists than is common in the nuclear industry, hence, good practices need to be ensured by repeated instruction and inspection.

Two techniques for transporting radioactive materials that need special consideration are the exclusive-use vehicle and the overpack. Both are effective for shipping radioactive material packages with large collective TI values. Their use permits setting limits that are based on potential radiation doses to persons nearby rather than on the total TI, which to a great extent represents radiation absorbed within other packages. Measurements in this study indicated that, for stacked

Mo-99 generators, only the summed TI in the front row and approximately 15 percent of the summed TI in the second row contribute to the TI at the face of the pile. In addition, the regulations related to exclusive use vehicles assure that radiation protection measures are applied to drivers. These shipments, however, can then expose workers loading and unloading the exclusive use vehicles or disassembling the overpacks to elevated doses. Careful health physics control for these operations is needed to prevent the observed elevated doses.

During the 3-year study, vehicle accidents, package damage, or mistakes in packaging or labelling related to radioactive materials were encountered on nine occasions. Two accidents resulted in damaged vehicles but not in elevated radiation exposures. The only elevated radiation doses attributed to these incidents resulted from what is believed to have been an omission of necessary shielding material.

Measurements with personnel dosimeters for two years showed that fewer than one-half of the workers considered to be exposed to the highest radiation doses from radioactive material packages received doses measurably above the radiation background. Ten workers in 1978-79 and fifteen workers in 1979-80 were exposed to radiation from these packages at rates between 0.5 and 5 R/year. With the exception of one sorter at a ground-forwarder terminal, these workers were all drivers on routes that delivered numerous Mo-99 generators. The elevated doses are attributed mainly to levels near 2 mrem/hr at the driver's seat plus exposure during loading and unloading. Special attention needs to be given to reducing radiation doses while loading and unloading and to maintaining low doses at the driver's seat. Issuing radiation dosimeters to workers at terminals is desirable to identify problem locations. The dosimetry program need not be continued if doses to workers are consistently at the radiation background.

The trend toward further controls of radioactive materials shipments by states has resulted in regulations by Georgia that require notification of shipment by motor vehicle as well as annual reports. These regulations will provide better information concerning the magnitude of shipments and also should permit prompt response in cases of accidents or incidents. Surveys of motor vehicle carriers of radioactive materials on highways as practiced in Illinois would be an effective adjunct to this program. Other means of transport -- by railroad, airplane, and barge -- should also be considered for compliance monitoring.

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Appendix A

RAM Carriers in Georgia Contacted in Third Year of Study

Airlines

Passenger:
- Delta Airlines (C)*
- Eastern Airlines (G)
- Piedmont Airlines (P)
- Republic Airlines (B)

Air Cargo Service:
- Airborne Freight (K)
- Airlift International (F)
- Burlington Northern Air Freight (no data)
- Emery Air Freight (E)
- Federal Express (A)
- Flying Tiger Line (H)
- Kenworthy Air Freight (L)
- Midwest Air Services (J)
- Profit by Air (I)
- Summit Airlines (O)
- Zantop Airlines (N)

Truck Lines

Interstate Carrier:
- Associated Courier (AC)
- Chem-Nuclear Systems, Inc.**
- Hittman Transport Services, Inc.**
- Home Transportation Co.
- McCormack Hwy. Transportation, Inc.**
- New England Nuclear (NE)
- Thurston Transportation Co.
- Skycab (SK)
- Tri-State Motor Transit Co.

Ground Forwarder:
- Purolator Courier (D)

* carriers are identified in report by letters in parentheses
**carrier was contacted by telephone only

Appendix B-1

Summary of Radiopharmaceutical Shipments Delivered to the Ground Forwarder Terminal at Atlanta on Weekends during 1979-1980 by Three Major Suppliers

Origin, Manufacturer	Destination, State	No. of weekends	Radionuclide, no./week			Activity, Ci/wk	TI per week	Category, no./week				Total no./week
			I-131	Mo-99	Other			Ltd	I	II	III	
NE	AL	8	0	11.5	17.8	12.6	39.9	2.0	12.8	3.0	14.2	32.0
	FL (1)	7	0	2.7	2.4	4.0	10.2	0.1	2.0	0.3	2.7	5.1
	GA	8	0	14.8	19.8	18.4	62.6	3.4	12.9	5.6	15.1	37.0
MA	GA	11	16.3	20.8	4.4	21.9	40.7	1.4	0	16.7	23.4	41.5
SQ	AL	3	0.7	15.3	1.3	26.9	37.4	0.7	0	1.0	15.7	17.3
	FL (1)	3	0	2.0	0	5.1	5.4	0	0	0	2.0	2.0
	GA	3	1.7	15.3	0	23.9	33.0	0.7	0	1.3	16.0	18.0
	TN	3	3.0	12.0	0.7	20.0	29.2	0.3	0	1.0	14.3	15.7
TOTAL			21.7	94.4	46.4	132.8	258.4	8.6	27.7	28.9	103.4	168.6

(1) RAM routed through Montgomery, AL destined for areas in the Florida panhandle.
(2) NE: New England Nuclear
MA: Mallinckrodt
SQ: Squibb

Appendix B-2

Monthly Summary of RAM Shipments, Eastern Cargo Terminal, Atlanta, Outbound

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III
May									
1	Atlanta	MSY	H-3	0.015	-		1		
1	EWR	MSY	I-131	0.014	2.1				1
1	ORD	AGS	Fe-59	0.001	0.2			1	
1	Atlanta	JFK	Y-90	0.46	1.5				1
1	Atlanta	ORD	Y-90	0.36	1.5				1
5	ORD	BHM	Ga-67	0.013	0.5			1	
6	Atlanta	MGM	Mo-99	0.45	2.0				1
6	ORD	CHA	Ga-67	0.012	0.4			1	
6	ORD	CHA	I-123	0.002	0.1			1	
6	Atlanta	CHA	Tl-201	0.004	-		1		
7	Atlanta	LEX	Tl-201	0.004	-		1		
7	Atlanta	CHA	Tl-201	0.006	-		1		
7	TLH	PHL	I-125	768 uCi	-		1		
7	Atlanta	BHM	Se-75	0.001	0.2			1	
7	DFW	MLU	Ga-67	0.003	0.1			1	
7	ATL	MSY	H-3	0.025	-		1		
7	ATL	CHS	Se-75	0.001	0.2			1	
8	ATL	CHA	I-123	0.004	0.1			1	
8	ATL	PNS	I-125	10 uCi	-	1			
8	ATL	MEM	Tl-201	0.012	-		1		

Appendix B-2 (cont'd)

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III
8	ATL	LEX	Tl-201	0.004	-		1		
8	ATL	CHA	Tl-201	0.004	-		1		
8	ATL	CHA	Tl-201	0.002	-		1		
8	ATL	CHA	Tl-201	0.002	-		1		
13	ATL	MGM	I-131	0.45	2.0				1
13	ATL	CHA	Tl-201	0.004	-		1		
14	Unknown	GNV	Unknown (Solution Sodium Iodine)	0.010	Unknown			1	
15	EWR	MSY	I-131	0.014	3.0				1
17	DTW	AGS	I-131	0.013	0.6			1	
22	ATL	TPA	I-131	0.008	1.1				1
22	ATL	CHA	Co-57	2.6 uCi	0.1			1	
23	Unknown	MSY	In-125	0.001	-	1			
23	Unknown	MSY	I-131	0.014	3 0				1
25	LAC	MIA	C-14	0.002	-		1		
26	LAX	BHM	I-125	0.002	-		1		
27	ATL	MIA	Tl-201	0.002	-		1		
27	ORD	CHA	I-123	0.003	0.1			1	
28	Unknown	MSY	I-125	0.001	-		1		
			Totals	1.9	18.8	2	16	12	8

Note: Data were obtained from Eastern Restricted Articles forms.

Appendix B-3

Monthly Summary of RAM Shipments, Eastern Cargo Terminal, Atlanta, Terminating*

1980 Date	Origin	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks**
May									
1	STL	I-131	0.011	0.4			1		
5	EWR	I-125	0.001	-	1				Picked up by Sonic Deliv.
5	STL	Cr-51	0.001	0.1			1		
5	EWR	Mo-99	2.3	1.6				1	
5	EWR	Mo-99	2.3	1.6				1	
5	EWR	Mo-99	1.4	1.3				1	
6	STL	Mo-99	5.0	3.8				2	
7	STL	I-131	0.099	1.8				2	
11	LGA	I-123	0.0003	0.1			1		
12	STL	I-131	0.060	1.5				1	
12	LGA	I-123	0.0003	0.1			1		
13	LGA	I-123	0.0003	0.1			1		
13	STL	I-131	0.056	1.0				1	
13	STL	I-125	0.0002	-	1				
13	STL	I-125	0.0002	-	1				
13	EWR	Mo-99	Unknown	5.5				4	
13	EWR	I-125	0.001	-	1				Picked up by Sonic Deliv.
13	EWR	Cr-51	0.0014	0.1			1		" "
13	EWR	Co-57	2.8 uCi	0.1			1		" "
13	STL	Mo-99	5.0	3.8				2	
14	BUF	I-131	0.037	0.7				1	
14	LGA	I-123	0.0003	0.1			1		
14	STL	Cr-51	0.001	0.1			1		
15	EWR	Cr-51	0.0069	0.6			1		Picked up by Sonic Deliv.
15	EWR	Co-57	2.8 uCi	0.2			1		
18	LGA	I-123	0.0003	0.1			1		

Appendix B-3 (cont'd)

1980 Date	Origin	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks**
19	STL	I-131	0.036	1.2				1	
19	LGA	I-123	0.0084	0.4			1		
19	LGA	Ga-67 Xe-133 I-123	0.010 0.010 0.009	0.7			1		Overpack
19	AUS	Cd-109	0.005	-	1				Deliv. Co unknow
19	AUS	Fe-55	0.045	(Exempt)					Deliv. Co unknow
20	STL	Mo-99	5.0	3.8				2	
20	LGA	I-123 Ga-67	0.0084 0.024	0.5			1		Overpack
20	EWR	Mo-99	1.4	1.3				1	
20	EWR	Mo-99	2.3	1.6				1	
20	EWR	Mo-99	2.3	1.6				1	
20	STL	I-125	0.001	0.1			1		
21	STL	I-131	0.19	1.6				1	
21	STL	I-131	0.081	1.2				1	
22	EWR	I-125	0.001	-	1				Picked up by Sonic Deliv.
22	STL	I-131	0.005	0.2			1		
22	STL	Ga-67	0.020	0.5			1		
26	EWR	Mo-99	2.3	1.9				1	
26	EWR	Mo-99	2.3	1.9				1	
26	EWR	Mo-99	1.1	1.6				1	
26	EWR	Mo-99	0.56	1.0				1	
26	LGA	I-123	0.0048	0.2			1		
26	LGA	Xe-133	0.020	-		1			
26	LGA	Xe-133 I-123 Ga-67	0.040 0.012 0.040	0.7			1		Overpack
27	LGA	Co-60	2 uCi	0.1			1		Picked up by Sonic Deliv.
27	STL	I-131	0.056	1.3			3		
27	LGA	I-123	0.0018	0.1			1		

Appendix B-3 (cont'd)

1980 Date	Origin	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks**
27	LGA	Xe-133 Ga-67 I-123	0.030 0.024 0.0096	0.6			1		Overpack
27	STL	Mo-99	5.0	3.8				2	
28	STL	I-125	0.0002	-	1				
28	STL	I-131	0.053	0.7			1		
29	STL	I-131	0.033	0.7			1		
29	STL	Ga-67	0.028	0.1			1		
29	EWR	I-131	0.0129	0.3			1		(1)
		TOTALS	39.2	54.4	7	1	30	30	

*Data were obtained from airbills, shipping certificates and restricted articles forms.

**RAM picked up by Purolator Courier unless otherwise indicated.

NOTE: (1) Picked up by Sonic Delivery. Air bill showed five pieces at 86 lbs; however, it is unknown if other 4 pieces were RAM. Only shipper's certificate, (Atlanta 1/5) was present, which agreed with air bill.

Appendix B-4

Monthly Summary of RAM Shipments, Delta Cargo Terminal, Atlanta, Outbound*

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks
May										
9	Atlanta	Lexington	Xe-133	0.010	-		1			NEN RAM
10	Atlanta	Lexington	Tl-201	0.004	-		1			NEN RAM
10	Atlanta	Lexington	Xe-133	0.100	-		1			NEN RAM
15	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckro RAM
15	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckro RAM
15	ORD	BNA	P-32	0.001	-	1				Amersham R
15	ORD	BNA	H-3	0.101	-		1			Amersham R
16	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckro RAM
16	Atlanta	TYS	I-131	0.001	0.1			1		Mallinckro RAM
20	Atlanta	TYS	I-131	0.009	0.4			1		Mallinckro RAM
24	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
24	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
24	Atlanta	MCO	Xe-133	0.040	-		1			NEN RAM
24	Atlanta	MCO	Tl-201	0.006	-		1			NEN RAM
28	Atlanta	MCO	Xe-133	0.060	-		1			NEN RAM
28	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
28	Atlanta	MCO	Tl-201	0.002	-		1			NEN RAM
28	Atlanta	MIA	Tl-201	0.006	-		1			NEN RAM
28	Atlanta	MIA	Tl-201	0.008	-		1			NEN RAM
28	Atlanta	MIA	Xe-133	0.080	-		1			NEN RAM
				TOTAL	0.8	1	14	5	0	

*Data were obtained from Delta Restricted Articles to Pilot Notification forms.

Appendix B-5

Monthly Summary of RAM Shipments, Republic (formerly Southern) Airlines, Atlanta, Outbound*

Date, 1980	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks
May										
12	Orangeburg, NY	New Orleans, LA	I-125	3.5 uCi	-	1				Profit by Air shipper
13	Orangeburg, NY	New Orleans, LA	I-125 Co-57	3.0 uCi 1.5 uCi	-	1				Overpack Profit by Air shipper
14	Unknown	Memphis, TN	Unknown	unknown						Ab 032 ATL 5720-8126 did not reflect RAM: however, Restriction Articles Pilot Notification indicated RAM NOS.
16	Orangeburg, NY	New Orleans, LA	Co-57	3.0 uCi	-	1				Profit by Air shipper
20	Skycab East Brunswick, NJ	Panama City, FL	Mo-99	unknown	1.6				1	
31	St. Louis, MO.	Sioux City, IA	Mo-99	1.5	1.7				1	Restricted Articles Pilot Notification listed radionuclide as Ga- 67.
31	St. Louis, MO.	Bemidji, MN	Mo-99	3.0	2.5				1	Restricted Articles Pilot Notification listed radionuclide as Ga-67.
			Totals	4.5	5.8	3	0	0	3	

*Data were obtained from air bills and shipper's certificates or Pilot Notification forms. There was no record of any RAM terminating in Atlanta, Georgia during this period.

Appendix B-6

Monthly Summary of RAM Shipments: Emery Air Freight, Atlanta

Date, 1980	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks
May										
1	Atlanta, GA	Chicago, IL	Y-90	Unknown	unk				1	Via Delta AB006 ATL-1878-8965
2	Oak Ridge, TN	Gamma Industries	Ir-192	7,801	1.4				1	
		Baton Rouge, LA	Ir-192	7,585	1.3				1	
7	Atlanta, GA	Dallas/Ft Worth, Tx	Kr-85	unknown	unk		unknown			Air bill cross referenced to RAM on Flying Tiger shipments on May 7, 1980. RAM come from GA Tech.
28	Oak Ridge, TN	Baton Rouge, LA	Ir-192	8,363	1.5				1	
30	Oak Ridge, TN	Baton Rouge, LA	Ir-192	7,938	1.6				1	
unknown	Oak Ridge, TN	New Orleans, LA	Ir-192	5,945	0.7				1	
			Totals	37,632	6.5				6	

Note: Data obtained from inbound/outbound air bills.

Appendix B-7

Monthly Summary of RAM Shipments: Flying Tiger, Atlanta*

Date, 1980	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III	Remarks
May										
7	Oak Ridge, TN (BNA Airport)	San Francisco, CA	Kr-85	30	0.3			1		Emery Air Freight to Atlanta
7	GA Tech Atlanta, GA	Dallas, TX	Kr-85 H-3	1.8 0.53	1.5				1	Emery Air Freight
16	Knoxville, TN	San Francisco, CA	H-3	2,382	-		1			Airborne (Cape Air Freight)
22	Oak Ridge, TN	Industrial Nuclear Co San Francisco, CA	Ir-192	3,688	0.8			1		
27	3 M St Paul, MN	3 M Caroline, Puerto Rico	Po-210 Po-210 Po-210	0.1 0.4 0.85	- - -		1 1 5			Bonded in ceramic, solids
31	Oak Ridge, TN	Industrial Nuclear Co Foster City, CA	Ir-192	3,612	0.4			1		
			Totals	9,716.	3.0	0	8	3	1	

*Data were obtained from air bills, air way bills and shipper's certificates.

Appendix B-8

Monthly Summary of RAM Shipments,
Kenworthy Air Freight, Atlanta*

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III
Outbound									
April									
1	ORD	DFW	I-125	0.006	0.9			1	
			Cr-51	0.002	0.1			1	
			S-35	0.025	---		1		
			C-14	0.001	---		1		
			I-125	0.005	0.1			1	
			C-14	10 uCi	---	1			
1	ORD	MEM	C-14	0.0001	---	1			
2	JFK	MIA	H-3	0.002	---		1		
			H-3	0.005	---		1		
2	ORD	MEM	P-32	0.070	0.1			1	
2	ORD	DFW	I-125	0.060	0.3			1	
			Fe-59	0.001	0.4			1	
			C-14	0.002	---		1		
			Cd-109	5 uCi	---	1			
3	ORD	MEM	P-32	0.001	---	1			
			C-14	0.0003	---	1			
			I-125	2.5 uCi	---	1			
3	ORD	DFW	I-125	0.0005	0.1			1	
			C-14	0.001	---	1			
			Co-57	3 uCi	---	1			
			Cd-104	5 uCi	---	1			
3	JFK	ASY	H-3	0.002	---		1		
4	ORD	MEM	I-125	50 uCi	---	1			
			Co-57	6 uCi	---	1			
			Co-57	28 uCi	---	1			
			I-125	24 uCi	---	1			
4	ORD	DFW	I-125	7.7 uCi	---	1			
			I-125	0.0008	0.2			1	
8	ATL	MSY	Ir-192	3,191	0.4			1	
9	ORD	DFW	C-14	0.0006	---		1		
			Co-57	14 uCi					
			I-125	0.003	0.5			1	
			H-3	10 uCi	---		1		
			Cd-109	0.0002	--	1			
10	ORD	DFW	Th-228	5.4 uCi	0.1			1	
			C-14	0.0006	---	1			
			I-125	27 uCi	---	1			
			Co-57	7 uCi	---	1			

Appendix B-8 (cont'd)

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III
11	ORD	MEM	I-125	6 uCi	---	1			
12	ORD	MEM	Co-57	21 uCi	---	1			
			Co-57	14 uCi	---	1			
14	ORD	DFW	I-125	0.066	0.6			1	
			C-14	0.0016	---		1		
			Co-57	14 uCi	---	1			
			Se-75	10 uCi	---	1			
15	ORD	MEM	I-125	0.005	0.1			1	
			H-3	0.005	---		1		
			P-32	0.001	---	1			
			I-125	0.005	0.1			1	
			S-35	0.012	---				
15	JFK	DFW	H-3	0.015	---		1		
15	ATL	MSY	Ir-192	7,997	1.5				1
			Ir-192	8,013	1.5				1
15	ORD	DFW	I-125	0.002	0.2			1	
			H-3	0.004	---		1		
			S-35	0.005	---		1		
			Co-57	3 uCi	---	1			
16	JFK	DFW	H-3	0.010	---		1		
16	ORD	DFW	I-125	0.010	0.1			1	
			H-3	0.105	---		1		
17	ORD	DFW	H-3	0.003	---		1		
			I-125	0.0003	0.2			1	
18	ORD	MEM	I-125	0.050	0.1			1	
			H-3	0.001	---	1			
18	ORD	DFW	I-125	0.0008	0.2			1	
19	ORD	MEM	S-35	0.001	---	1			
21	ORD	DFW	I-125	0.028	1.4				1
			Cr-51	0.040	0.2			1	
			P-32	0.005	---		1		
			H-3	0.002	---		1		
			S-35	0.002	---		1		
22	JFK	DFW	H-3	0.005	---		1		
22	ORD	MEM	S-35	0.002	---		1		
			P-32	0.0012	---		1		
			I-125	1.2 uCi	---	1			
			H-3	25 uCi	---	1			
22	ORD	DFW	I-125	0.035	0.3			1	
			Co-57	7 uCi		1			
22	MIA	JFK	I-125	5 uCi	---	1			
23	ORD	MEM	I-125	0.15	0.4			1	
			S-35	0.005	---		1		
			P-32	0.001	---	1			
23	ORD	DFW	I-125	0.057	0.3			1	
			H-3	0.0007	---	1			
			Co-57	7 uCi	---	1			

Appendix B-8 (cont'd)

1980 Date	Origin	Destination	Isotope	Curie	TI	Category Ltd	I	II	III
24	ORD	MEM	I-125	0.010	0.2			1	
TOTALS				19,201	10.6	35	23	24	3
Terminating									
April									
1	ORD	ATL	Cr-51	0.002	0.1			1	
			P-32	0.0025	---		1		
			I-125	40. uCi	---	1			
2	JFK	ATL	H-3	0.005	---		1		
2	ORD	ATL	Ba-140	5.4 uCi	0.1			1	
			I-125						
			S-35	0.020	0.2			1	
			C-14						
			P-32						
3	ORD	ATL	V-48	0.001	0.9				1
			Rb-86						
			S-35	0.006	0.5			1	
			C-14						
10	ORD	ATL	I-125	0.0006	0.2			1	
			H-3	60. uCi	---	1			
			S-35	0.0001	---	1			
			Co-57	14. uCi	---	1			
15	ORD	ATL	I-125	0.010	0.1			1	
			S-35	0.0005	---	1			
			H-3	0.0001	---			1	
16	JFK	ATL	H-3	0.017	---		1		
			H-3	0.002	---		1		
TOTALS				0.072	2.1	6	4	6	1

* Data for period 1-24 April 1980 only. Data were obtained from flight breakdown fi
and shipper's certificates.

Appendix B-9

Monthly Summary of RAM Shipments,
Summit Airlines, Atlanta*

Date 1980	Origin	Destination	Isotope	Curie	TI	Category	Remarks
			OUTBOUND				
5/29	Oak Ridge, TN	JFK	H-3	5,000	--	I	NOS special form. Type A container.
6/10	Universal Co Decatur, AL	CHL	Am-241 Cs-137	0.0084 0.04	0.5	II	
6/24	Oak Ridge, TN	JFK	H-3	5,000	--	I	USA 5552/B container.
7/11	Oak Ridge, TN	JFK	H-3	5,000	--	I	
			TERMINATING				
May	NONE						
6/18	Micromedic Systems, Horsham, PA (PHL)	ATL	I-125	<0.002		Ltd.	

*Data were obtained from Air Bills and Pilot Notification Restricted Articles forms.

Appendix B-10

RAM Shipments from Georgia Institute of Technology Nuclear Research Center
(November 1978 - October 1979)

Date	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category
1978						
11/9	University of Texas	Federal Express	H-3	1.8	1.2	III
	University of Texas	Federal Express	Kr-85	1.1		
	University of Texas	Federal Express	H-3	1.8	1.2	III
	University of Texas	Federal Express	Kr-85	1.1		
	University of Texas	Federal Express	H-3	1.8	1.2	III
	University of Texas	Federal Express	Kr-85	1.1		
11/15	Med. Research Foundation, GA	Hand carried	Y-90	2.6	0.5	I
11/22	Florida State University	Federal Express	P-32	0.0001	0.1	II
	University of Arkansas	Federal Express	K-42	0.0001	0.2	II
11/29	Applied Physical Tech., GA	APT vehicle	Co-60	0.0007	0.1	II
12/4	University of Arkansas	US mail	AC	trace	-	Ltd
12/6	University of Florida	Federal Express	Na-24	0.003	0.2	II
12/12	Florida State University	Federal Express	Mo-99	0.002	0.2	II
12/13	Med. Research Foundation, GA	Hand carried	Y-90	0.75	0.8	II
	DOE, Idaho Falls, ID	Delta Airlines	Fe-55 P-32	1 µCi	-	Ltd
12/18	Med. Research Foundation, GA	Hand carried	Y-90	0.080	0.6	II
12/21	University of Florida	U Haul U of FL vehicle	Co-60	1 µCi	-	I
1979						
1/5	University of Florida	U of Fl vehicle	Co-60	0.0002	0.1	II
1/15	Med. Research Foundation, GA	Hand carried	Y-90	1.4	0.7	II
1/22	University of Nebraska	Federal Express	Na-24	0.0001	-	I
	Florida State University	Federal Express	P-32	10 µCi	-	I
1/31	Med. Research Foundation, GA	Hand carried	Y-90	0.1	0.2	II
2/1	Georgia State University	Hand carried	Tb-161	30 µCi	0.5	II

Appendix B-10 (cont'd)

Date	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category
2/9	Emory University, GA	Hand carried	Zn-69	0.001	3.0	II
	Georgia Marine Institute, GA	US mail	C-14	10 µCi	-	Ltd
2/12	US EPA, AL	Greyhound Express	Fe-55	1 µCi	-	Ltd
2/13	Med. College of Georgia	Hand carried	F-18	0.0045	1.5	II
2/14	Med. Research Foundation, GA	Hand carried	Y-90	0.63	0.5	II
2/21	Med. Research Foundation, GA	Emery Air Freight	Y-90	1.7	1.0	II
	SRP, SC	Personal vehicle	Ta-182	0.005	0.8	II
2/27	New York University	Federal Express	H-3	1.4	-	I
2/28	University of Arkansas	US mail	AC	trace	-	Ltd
3/6	Bell Telephone, PA	Federal Express	Cd-115	0.0005	0.1	II
	University of Arkansas	US mail	Fe-59	trace	-	Ltd
3/7	Bell Telephone, PA	Federal Express	Ru-103	50 µCi	0.1	II
3/9	University of Kentucky	UKY vehicle	Na-24	0.0006	0.5	II
	University of Kentucky	UKY vehicle	Na-24	0.001	0.9	II
3/21	Med. Research Foundation, GA	Hand carried	Y-90	2.0	0.8	II
3/29	University of Arkansas	Federal Express	H-3	0.0005	0.2	II
	SRP, SC	SRP vehicle	Ta-182	0.005	0.8	II
5/16	University of Arkansas	US mail	Zn-65	0.0009	-	Ltd
5/24	Med. College of Georgia	Hand carried	F-18	0.003	0.5	II
5/28	University of Florida	U of FL vehicle	Co-60	10 µCi	0.7	II
5/31	University of Arkansas	ABF Truck Line	H-3	0.0008	0.6	II
6/5	SRP, SC	GA Tech vehicle	Co-60	7 µCi	0.1	II
6/12	Babcock & Wilcox, VA	Federal Express	DU	700 grams	0.2	II
		Federal Express	Th-232	0.00016		
6/15	University of Arkansas	ABF Truck Lines	Zn-65	0.0002	0.9	II
6/18	United Tech Research Ctr, CT	Federal Express	Cr-51	1 µCi	-	Ltd
6/29	University of Georgia	State vehicle	C-14	0.005	0.1	II
7/6	United Tech Research Ctr, CT	US mail	Cr-51	0.001 µCi	-	
7/12	University of Arkansas	US mail	Zn-65	0.001	-	Ltd
7/25	E.I. DuPont, SRP, SC	GA Highway Express	Ta-182	0.0001	2.0	III
8/3	University of Texas	Federal Express	Kr-85	0.13	0.5	II
	University of Texas		H-3	0.54		
	University of Florida	FL vehicle (sole use)	Co-60	0.0003	1.5	II
8/6	Proctor & Gamble, OH	Federal Express	Na-24	0.002	0.3	II

Appendix B-10 (cont'd)

Date	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category
8/9	United Tech Research Ctr, CT	Federal Express	Cr-51	15 μCi	0.1	II
	United Tech Research Ctr, CT	Federal Express	Cr-51			
8/15	E.I. DuPont, SRP, SC	Overnite	Cr-51	0.0001	0.2	II
8/21	Med. College of Georgia	Hand carried	F-18	0.003	0.7	II
8/23	E.I. DuPont, SRP, SC	Hand carried	H-3	0.31	-	I
9/5	Applied Physical Tech, GA	APT personal vehicle	Co-60	0.0007	0.4	II
9/7	University of Texas	Federal Express	Kr-85	0.10	0.4	II
			H-3	0.88		
	University of Texas	Federal Express	Kr-85	0.08	0.4	II
			H-3	0.88		
9/7	Ctr for Neurochemistry, NY	US mail	H-3	0.0001	-	Ltd
9/10	Bureau National de Metrologie, France	Aircraft	Ba-133	4 μCi	0.1	I
	US Geological Survey, VA	Federal Express	Na-24	0.0005	0.5	II
9/10	University of Arkansas	US mail	LSA AC	--	-	Ltd
	University of Miami	US mail	Zn-69	5 μCi	-	Ltd
9/11	Applied Physical Tech, GA	APT personal vehicle	Co-60	0.0007	0.4	II
9/17	US Geological Survey, VA	Federal Express	Na-24	0.0005	0.2	II
9/24	US Geological Survey, VA	Federal Express	Na-24	0.0003	0.7	II
10/1	US Geological Survey, VA	Federal Express	Na-24	0.0002	0.5	II
10/3	US Geological Survey, VA	Federal Express	Na-24	0.0002	0.9	II
	Proctor & Gamble, OH	Federal Express	Na-24	0.0005	0.3	II
10/4	University of Arkansas	US mail	LSA	--	-	Ltd
	US Army Engineers, MS	Federal Express	Kr-85	0.3 μCi	-	Ltd
	Med. Research Foundation, GA	Hand carried	Y-90	0.328	0.3	II
10/5	Law Engineering & Testing, GA	Hand carried	Kr-85	9 μCi	0.1	Ltd
	Med. Research Foundation, GA	Hand carried	Y-90	0.0004	0.4	II
10/8	US Geological Survey, VA	Federal Express	Na-24	0.0004	1.3	III
10/11	Health Physics Off. University Park, PA	Unknown	H-3	0.002	-	I
10/12	University of Texas	Federal Express	H-3	2.88	1.9	III
			Kr-85	0.81		
10/15	US Geological Survey, VA	Federal Express	Na-24	0.0006	1.6	III
10/17	US Geological Survey, VA	Federal Express	Na-24	0.0004	1.7	III
	University of Kentucky	UKY vehicle	Na-24	50 μCi	0.2	II

Appendix B-10 (cont'd)

Date	Destination	Shipping Mode	Isotope	Activity, curie	TI	Category
10/18	Florida State University	Federal Express	Sm-153	0.0001	2.0	III
10/19	Emory University, GA	Hand carried	Cd-111m	0.0005	unk	II
			Br-80	0.020		
10/22	Sunoco Products, SC	Federal Express	Kr-85	2.2	5.0	III
			H-3	5.0		
	US Geological Survey, VA	Federal Express	Na-24	0.0002	0.1	II
10/23	Sunoco Products, SC	Emery Air Freight	Kr-85	2.2	6.0	III
			H-3	5.0		
	US Geological Survey, VA	Federal Express	Na-24	0.0002	0.3	II
10/24	Sunoco Products, SC	Emery Air Freight	Kr-85	2.2	5.0	III
			H-3	5.0		
	University of Arkansas	Federal Express	Pa-233	15 µCi	0.2	II
	US Geological Survey, VA	Federal Express	Na-24	0.0002	0.7	II
10/25	Wyle Lab, Huntsville, AL	US mail	AC	--	-	Ltd
10/26	University of Texas	Federal Express	Kr-85	1.16	1.8	III
			H-3	1.26		
	University of Texas	Federal Express	Kr-85	0.74	1.0	III
			H-3	1.70		
10/29	US Geological Survey, VA	Federal Express	Na-24	0.0004	0.9	III
10/31	US Geological Survey, VA	Federal Express	Na-24	0.0004	1.2	III

Notes: 1. Information obtained from Radioactive Isotope Shipment Log.
2. AC: activation products
DU: depleted uranium

Appendix B-11

Shipments of Ir-192 Radiography Sources
to and from Two Radiographers*

Supplier	Carrier	Date	Activity, curies	TI	Category	Remarks
Source Production and Equipment	Emery Air Freight**	4/2/79	0	--	I	Returned shipping container (depleted U)
Source Production and Equipment	Federal Express**	4/30/79	102	unk	unk	
Source Production and Equipment	Red Ball Express**	4/30/79	0	--	--	Returned shipping container (depleted U)
Source Production and Equipment	Federal Express**	5/30/79	102	2.0	III	
Source Production and Equipment	Federal Express**	5/31/79	28	0.2	II	Returned source
Source Production and Equipment	Federal Express**	9/28/79	110	2.5	III	
Source Production and Equipment	Federal Express**	2/6/80	105	1.0	III	
Source Production and Equipment	Federal Express**	2/4/80	8	1.0	III	Returned source
Technical Operations (RAD Prod. Division)	Roadway Express**	5/31/79	0	--	--	Returned 2 shipping containers
Technical Operations (RAD Prod. Division)	Roadway Express**	6/11/79	1.7 5.5	unk unk	unk unk	Returned 2 sources
Gamma Industries	Federal Express	8/22/79	80	2.0	III	
Gamma Industries	Mercury Freight	4/8/80	10	0.5	II	Returned source

Appendix B-11 (cont'd)

Supplier	Carrier	Date	Activity, curies	TI	Category	Remarks
Gulf Nuclear	Federal Express	9/18/79	100	2.0	III	
Gulf Nuclear	Mercury Freight	7/3/80	7	0.5	II	Returned source
Gamma Industries	Federal Express	3/31/80	103	2.5	III	
Gamma Industries	Federal Express	6/4/80	100	2.8	III	

Notes: * Information was from company records.

** McPherson Nondestructive Testing, Inc., Norcross; all others were for Law Engineering Testing Co., Atlanta.

Appendix B-12

Radioactive Waste Shipments from Georgia Institute of Technology Reactor to Barnwell, SC for Burial

Date, 1979	Carrier	Isotope	Activity, curie	TI	Remarks
1/18	Thurston Transportation Company	LSA	unk	-	Combined shipment GA Tech 62 pieces Emory 205 pieces Morehouse 11 pieces
4/17	Thurston Transportation Company	LSA	unk	-	Combined shipment GA Tech 22 pieces Emory 147 pieces Morehouse 7 pieces
10/18	Home Transportation Company	RAM waste, Sr-90	47.7	-	Cask CNSI 15-160B secured to trailer
11/27	Thurston Transportation Company	LSA Contaminated shield	unk	-	Combined shipment GA Tech 73 pieces Emory 160 pieces Morehouse 7 pieces

Appendix B-13

Monthly Reports of Radioactive Materials
Shipped by Truck through Georgia (a)

1980 Date	Origin/Destination/Carrier	Number
July (b)	Alabama to South Carolina	
	Chem Nuclear	2
	Tri State	8
	Florida to South Carolina	
	Chem Nuclear	12
	McCormack	2
	Tri State	2
	Georgia to South Carolina	
	Chem Nuclear	2
	Tennessee to Florida (c)	
	Chem Nuclear	1
	Tennessee to South Carolina	
	Daily Express	1
	Tri State	1
	TOTALS	31
August	Alabama to South Carolina	
	Chem Nuclear	3
	Tri State	17
	Wyle Lab	1
	Florida to South Carolina	
	Chem Nuclear	11
	Tri State	1
	Georgia to South Carolina (Baxley)	
	Chem Nuclear	4
	Home	2
	Tennessee to South Carolina	
	Daily Express	1
	Hittman	19
	Tri State	3
	TOTALS	62
September	Alabama to South Carolina	
	McCormack	2
	Tri State	13

1980 Date	Origin/Destination/Carrier	Number
	Florida to South Carolina	
	Chem Nuclear	7
	Tri State	2
	Georgia to South Carolina (from Baxley)	
	Chem Nuclear	4
	Home	2
	Tri State	2
	(from Folkston)	
	Chem Nuclear	2
	South Carolina to Folkston, GA	1
	Tennessee to South Carolina	
	Chem Nuclear	1
	Hacke	3
	Hittman	21
	Tri State	1
	TOTALS	61

Notes: (a) Data were obtained from Georgia Department of Transportation, Monthly Report of Hazardous Material Movements, and telephone contact with carriers regarding resolution of questions for several shipments. The Georgia Act does not apply to transport, delivery or acceptance for transport of radioactive materials under the direction or supervision of the United States Nuclear Regulatory Commission or the Department of Defense where such transport, delivery or acceptance for transport are escorted by personnel designated by or under authority of those agencies.

(b) July figures do not include 27-28 shipments by a major carrier of radioactive waste from the northern states through Georgia; however, those shipments are included in August and September totals.

(c) This shipment, consisting of 45 drums reportedly from Chattanooga, TN to Florida, could not be confirmed from information available.

Appendix C-1

Monitored RAM Packages

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
24 February					
D	0.75	Mo-99	2.3	III	MA to Milledgeville, GA (1.0)
D	1.35	Mo-99	4.0	III	NE to Alabama (2.2)
D	1.35	Mo-99	4.0	III	NE to LaGrange, GA (2.1)
D	1.35	Mo-99	4.0	III	NE to Vidalia, GA (2.3)
D	1.35	Mo-99	4.0	III	NE to Columbus, GA (2.3)
D	1.35	Mo-99	4.0	III	NE to Alabama (2.2)
D	1.35	Mo-99	4.0	III	NE to Alabama (2.2)
D	1.35	Mo-99	4.0	III	NE to Florida (2.2)
D	1.35	Mo-99	4.0	III	NE to Atlanta, GA (2.2)
D	1.35	Mo-99	4.0	III	NE to Columbus, GA (2.2)
D	1.35	Mo-99	4.0	III	NE to Atlanta, GA (2.2)
D	2.9	Mo-99	6.2	III	SQ to Atlanta, GA (2.3)
D	2.9	Mo-99	6.2	III	SQ to Atlanta, GA (2.0)
D	1.7	Mo-99	5.2	III	SQ to Atlanta, GA (2.2)
D	1.7	Mo-99	5.2	III	SQ to Macon, GA (2.1)
D	1.7	Mo-99	5.2	III	SQ to Macon, GA (2.3)
D	1.7	Mo-99	5.2	III	SQ to Montgomery, AL (2.1)
D	1.7	Mo-99	5.2	III	SQ to Montgomery, AL (2.2)
D	1.7	Mo-99	5.2	III	SQ to Montgomery, AL (2.5)
20 March					
C	0.38	Mo-99	1.4	III	SQ to Thomaston, GA (0.6)
C	0.010	I-131	0.4	II	SQ to Columbus, GA (0.2)
21 March					
C	0.006	I-131	0.2	II	SQ to Chattanooga, TN (0.1)
C	6.2 µCi	Co-57	0.1	II	SQ overpack to Lexington, KY (0.1)
I	0.005	Co-57	0.1	II	AM to Montgomery, AL (0.1)
I	0.005	I-125	0.1	II	AM to Birmingham, AL (0.1)
I	0.002	H-3	-	I	Schwarz/Mann Orangeburg, NY to Ft. Gordon, GA
I	10 µCi	unknown	-	Ltd	Schwarz/Mann Orangeburg, NY to Ft. Gordon, GA

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
D	0.0011	Cr-51	0.1	II	SQ to Nashville, TN (0.1)
D	0.021	I-131	0.7	II	SQ to Montgomery, AL (0.3)
D	6.4 µCi	Co-57	0.1	II	SQ to Gainesville, GA (0.1)
23 March					
D	1.7	Mo-99	5.2	III	SQ to Atlanta, GA (2.3)
D	2.8	Mo-99	6.2	III	SQ to Atlanta, GA (1.7)
D	2.8	Mo-99	6.2	III	SQ to Atlanta, GA (1.7)
D	1.7	Mo-99	5.2	III	SQ to Dublin, GA (2.0)
D	1.7	Mo-99	5.2	III	SQ to Savannah, GA (2.2)
D	2.2	Mo-99	6.0	III	NE to Augusta, GA (3.3)
D	1.8	Mo-99	5.0	III	NE to Augusta, GA (2.7)
D	2.0	Mo-99	2.3	III	MA to Valdosta, GA (1.3)
D	0.75	Mo-99	2.3	III	MA to Thomasville, GA (1.0)
25 March					
D	0.005	I-131	0.3	III	MA to Augusta, GA (0.3)
D	3.0	Mo-99	2.0	III	MA to Atlanta, GA (1.5)
D	0.006	I-131	0.4	III	MA to Atlanta, GA (0.4)
D	0.001	Cr-51	0.1	II	MA to Birmingham, AL (0.1)
D	0.012	Ga-67	0.1	II	MA to Birmingham, AL (0.2)
D	0.0001	H-3	-	I	MA to Birmingham, AL
29 March					
D	1.7	Mo-99	5.2	III	SQ to Nashville, TN. RAM freight bill marked "REFUSED," 3/17/80. RAM returned to terminal D, Atlanta, GA and was picked up on March 29, 1980 for return to SQ. Returned package should have had category II labels. (0.1)
24 April					
L	0.1	Cs-137	0.4	II	RAM in special form. Ohmart Corp., Cincinnati, OH to Monsanto Co., Decatur, AL (0.2)

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
26 April					
D	1.1	Mo-99	3.6	III	SQ freight bill to Athens General Hospital dated 4/18. Box was marked "Return to Sender-Refused Shipment." Package returned to SQ on 4/26. (0.5)
14 May					
A	0.010	Cs-137			RAM In special form.
A	0.050	Am-241/Be	0.1	II	Brainard Kilman Drill Co., Tucker, GA to Coral Gables, FL. Package authorization and type were not visible. (0.2)
A	0.0004	U-235	-	I	168 grams DOT 6M Type B container from Oak Ridge, TN to SRP, Aiken, SC. Overnite Transportation Co. refused shipment. RAM held pending resolution.
A	0.0045	Ra-226	0.5	II	Seaman Nuclear Corp, Atlanta, GA to Pittsburgh, PA. (Density gauge.) Shipper failed to attach package seal after opening box to include papers. Terminal A applied tape for security. (0.5)
H	228	Ir-192	1.3	III	Type B RAM in special form. Technical Operations, Burlington, MA to Peru. Nails for package seal. Shipping papers were not available. (1.8)
C	0.49	Mo-99			Skycab overpack Newark Airport to
	0.002	I-131	1.0	III	Atlanta. Items loose inside box. Staples used for package seal; some staples were loose on top and bottom of overpack. (0.8)
C	0.0018	I-123	0.1	II	Medi-Physics overpack. Newark Airport to Brunswick, GA. (0.1)

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
C	0.010 0.020	I-123 Ga-67	0.6	II	Medi-Physics overpack. Newark Airport to Atlanta. (0.3)
C	0.0048 0.010	I-123 Xe-133	0.3	II	Medi-Physics overpack. Newark to Atlanta. (0.1)
C	0.002	P-32	0.1	II	NE, Boston, MA to Augusta, GA. Item loose inside box. Bottom and side of box were wet. Wipes taken showed no contamination. Package contained dry ice. (0.1)
17 May					
D	0.010	I-125	0.1	II	AM (Profit By Air) Chicago, IL to Augusta, GA. Item was loose inside package. (0.1)
D	0.00077	I-125	0.2	II	AM (Profit By Air) Chicago, IL to Ft. Gordon, GA (0.2)
D	0.037	I-131	0.7	III	MA overpack arrived in Atlanta on AB 007 STL 1208-1436, FLT 271/13 as 1 of 4 pieces; however, packages inside were destined for NY. Overpack labels were corrected to show all isotopes and TI. The box was resealed. (0.9). Associated Courier picked up RAM on 5/17/80 for return to manufacturer.
	(The following packages were found inside subject overpack)				
	0.001	Se-75	0.1		
	0.002	I-131	0.2		
	0.012	I-131	0.3		
	0.010	P-32	0.2		
	0.012	I-131	0.3		
	unknown	unknown	-	Ltd	
11 June					
H	0.0004	depleted Uranium	0.2	II	Lockheed GA Co. from Marietta, GA to Montreal, Canada (0.1)
H	0.080	Po-210	-	I (4)	Minnesota 3M. Staples used for package seal. From New Brighton, MN to San Juan, PR.
H	108	Ir-192	1.4	III	NRC USA/9032/B - type B RAM in special form. Technical Operations, Burlington, MA to Colombia (0.1)

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
C	0.046	Ga-67 Xe-133	0.4	II	Diagnostic Isotopes overpack Bloomfield, NJ to Atlanta, GA (0.2)
13 June					
M	2,500	Xe-133	0.1	II	NE (0.1)
M	2,500	Xe-133	0.1	II	NE (0.1)
K	0.010	I-125	0.1	II	AM, Chicago, IL to Gainesville, FL. RAM was being held pending proper shipping certificate. Item was loose inside (0.1)
16 June					
H	30,000	H-3	-	I	Type USA 5552/B RAM as a gas (3.13 grams) from Oak Ridge, TN to Bucks, England.
19 June					
H	3,460	Ir-192	0.3	II	USA DOT WC type B container from Oak Ridge, TN to Industrial Nuclear Co., Foster City, CA. (0.4)
H	0.029	depleted Uranium	0.2	II	Lockheed Georgia Co., Marietta, GA to Eastern Airlines, Miami, FL. RAM was being held pending disposition. TI was not listed on package labels, labels were not on opposite ends of box, and LSA was not listed on air bill. (0.2)
D	0.051	I-131	1.5	III	MA, St. Louis, MO to Atlanta, GA (1.5)
D	0.001	I-131	0.1	II	MA, St. Louis, MO TO Atlanta, GA (0.3)
20 June					
H	0.050	Xe-133	-	I	Medi-Physics overpack, Chicago, IL to Huntsville, TX
L	0.030 0.10 0.020 7 µCi	I-125 H-3 S-35 Co-57	0.4	II	AM (Profit By Air) overpack, Chicago, IL to Atlanta, GA. Staples used as seals. (0.1)
L	0.0012	H-3	-	I	AM (Profit By Air) overpack. Chicago, IL to Dallas/Ft. Worth, TX. Staples used as seals.

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
	0.0003	I-125	0.2	II	AM (Profit By Air) Chicago, IL to Memphis, TN. Staples used as seals. (0.1)
L	0.030 0.0052	I-125 H-3	0.2	II	AM (Profit By Air) overpack Chicago, IL to Dallas/Ft. Worth, TX. Staples used as seals. (0.1)
21 June					
D	253	Mo-99	3	II	SQ bill #31284I to Middle GA Hospital, Macon, GA dated 6/16/80. Package was consigned to Mediray, Inc., Tuckahoe, NY. Package was returned to Atlanta to be held for return by Skycab. Paperwork and lables showed Y II, 253 curies with TI of 3; however TI noted was only 0.5. New labels had been placed over original labels.
22 June					
I	0.050 0.0115	Cr-51 H-3	0.2	II	AM (Profit By Air) Overpack from Chicago, IL to Dallas/ Ft. Worth, TX (0.2)
D	0.050 (total)	Xe-133 I-123	0.4	II	Medi-Physics overpack from Newark Airport to Atlanta, GA (0.1)
23 June					
D	0.006	Ga-67	0.1	II	NE from Atlanta, GA to Concord, NC (0.1)
D	0.002	Tl-201	-	I	NE Georgia
30 July					
G	0.044	I-131	1.0	III	MA, overpack, St. Louis, MO to Atlanta, GA (1.2)
D	0.0012	S-35	---	I	NE Boston, MA to Atlanta, GA
D	0.0015	P-32	---	I	NE Boston, MA to Atlanta, GA

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
H	0.010	Ni-63	---	I	SRI, Birmingham, AL to Bendix Corp., Baltimore, MD. Package returned to shipper because of air bill errors. Package authorization and type were not on box.
H	0.010	C-14	---	I	AM, no address on package and paperwork missing. Sticker showed San Juan, PR. Tracer action was submitted. Assistance from terminal I was requested to help obtain paperwork so package could be shipped.
9 August					
D	0.077	I-125	0.2	II	AM to Ft. Gordon, GA (0.2)
D	0.5	Mo-99	1.5	III	MA to Canton, GA (1.0)
D	1.0	Mo-99	1.2	III	MA to Gainesville, GA (1.0)
D	0.75	Mo-99	2.3	III	MA to Milledgeville, GA (1.3)
D	0.010	I-131	0.5	III	MA to Columbus, GA (0.6)
12 August					
H	250	Kr-85	1.2	III	Oak Ridge, TN to Tris Tech International, Burbank, CA, USA/5552/B container (1.8)
H	0.011	Co-60	2.0	III	Laboratorium, Stuttgart, West Germany to Monsanto Textile, Guntersville, AL, RAM arrived on Sabena Airlines (1.8)
C	15.7	Mo-99	2.0	III	Union Carbide, NY airport to Atlanta. First of this type shipment noted in 3 years. (2.0)
G	3.0	Mo-99	2.5	III	MA overpack to Miami, FL (2.2)
G	1.5	Mo-99	1.7	III	MA to Miami, FL. Only 1 label on package (2.0). Above 2 RAM were involved in an incident at airport. Only 2 of 9 packages in shipment were monitored. Another package had a shipper's label over the III label.

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
13 August					
L	1.0	Mo-99	1.2	III	MA overpack. RAM returned to MA by Profit By Air (1.0)
19 August					
G	1.5	Mo-99	1.7	III	MA, St. Louis, MO to Pensacola, FL (1.3)
N	1.41	Mo-99	1.3	III	SQ overpack Newark, NJ Airport to Atlanta. Skycab shipper (1.3) Three other overpacks of Mo-99 in shipment not monitored. This was first observation of RAM at terminal N.
10 September					
E	0.4 0.1	Kr-85 H-3	0.6	II	GA Tech to University of Texas (0.6)
E	0.2 2.3	Kr-85 H-3	0.3	II	GA Tech to University of Texas (0.3)
E	0.9 0.6	Kr-85 H-3	1.0	III	GA Tech to University of Texas (1.0)
H	0.16	enriched Uranium	0.2	II	Oak Ridge to France. Type B USA/0002/B container. Fissile RAM paperwork not checked (0.2)
H	0.26	enriched Uranium	0.2	II	same as above
H	0.010	Cs-137	0.1	II	Halliburton Services, Duncan, OK to Miami, and to Venezuela. Density gauge. Shipper's certificate on box had special form encapsulation 0.50 curies. Box not marked as special form. Three II labels were on box but not on opposite sides of box. Other paperwork not checked (0.1)
H	0.00045	Ra-226	1.0	II	San Juan, PR to Maintenance Management, NY, NY. Paperwork not checked (0.9)

Appendix C-1 (cont'd)

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
17 September					
C	15 μCi 0.013	Co-57 I-131	0.5	II	SQ overpack Skycab shipper. Staples for security seal. Newark, NJ to Atlanta (0.3)
C	0.012	Tl-201	---	I	NE to Atlanta, GA
C	0.004	Tl-201	---	I	NE to Ft. Gordon, GA
E	0.001	C-14	---	I	EPA, Monticello, MN to US EPA, Gulf Breeze, FL. Bolt through locking ring used as seal. Two I labels on drum but not on opposite sides. No package authorization.
E	1.6 0.5	Kr-85 H-3	0.9	II	GA Tech to Texas Department of Water Resources, Austin, TX (0.8) Three other like items in shipment but not monitored.
H	---	---	---		Container, USA/6697/B type B, from Industrial Nuclear Company to Union Carbide, Oak Ridge, TN, marked empty, had a surface reading of 0.6 mR/hr and 0.03 mR/hr at 3 ft. Paperwork not checked.
18 September					
G	0.026	I-131	0.8	III	MA overpack to Birmingham, AL (1.1)
G	0.072	I-131	1.0	III	MA overpack to Atlanta, GA (1.9)
G					MA box marked USA DOT 7A, type A, no labels, had a surface reading of 12 mR/hr and 0.6 mR/hr at 3 ft. Above three pieces on air bill 007 STL 20838156, dated 9/17, were misrouted to Nashville, TN. RAM arrived Atlanta, 9/18, at 1125 hours. Shipper's certificates accounted for the two I-131 packages; however, it read "medical supplies, not radioactive, no

1980 Date and Location	Amount, Ci	Isotopes	Transportation Index	Category	Remarks*
					labels required," for the third piece. Same package was again remonitored at terminal D and had a TI reading of 0.6. Shelby Memorial Hospital, Alabaster, AL received this package. It was notified of above on September 22. MA was also notified. Box contained I-131. MA advised that corrective action had been taken and health physics will monitor RAM packages.
D	0.003	Ga-67	0.1	II	MA to Anniston, AL (0.1)
D	0.002	Tl-201	0.1	II	MA to Birmingham, AL (0.1)
D	0.005	P-32	0.1	II	MA to Birmingham, AL (0.1)
20 September					
D	0.077	I-125	0.2	II	AM to Sylacauga, AL. Envelope covered one II label. Staples were used as security seal (0.2)
D	0.0015	H-3/C-14	---	I	U of Texas, Houston, TX to Columbia, SC
D	0.0018	I-131	0.4	II	SQ to Augusta, GA (0.3)
D	0.0001	I-125	---	Ltd.	Roche Diagnostic, Belleville, NJ to Ft. Gordon, GA. Shipper's certificate indicated industrial type package.

* Type A package unless otherwise specified.
Origin and destination listed unless shipments were exclusively in Georgia.
Measured TI shown in parentheses.
Pertinent observations noted.

Appendix C-2

Summary of Radioactive Material Transport Vehicle Surveys in 1979-1980

	Radiopharmaceutical	Industrial, Research and Educational	Nuclear Fuel Cycle
No. of vehicles	98	2	1
Radiation levels, mR/hr			
Cab average (maximum)	0.8 (10)	0.05 (0.06)	0.11 (0.11)
Surface average (maximum)	29. (100)	1 (1.3)	9 (9)
6-ft distant average (maximum)	3.2 (18)	0.12 (0.13)	1.1 (1.1)
TI average (maximum)	61 (300)	---	LSA
Excessive removable contamination	none	none at origin*	none
Excessive radiation levels in cab	8 violations**	none	none
Excessive TI	3 violations***	none	none
Improper package placement		NA (cask & trailer load)	NA (cask)
Improper shipping documents	2 of 88 vehicles	none	none
Insufficient placards	7 of 92 vehicles	none	none

* Upon arrival at Barnwell, SC it was reported the 2-ton contaminated shield leg punctured the base of the container and slightly contaminated the trailer, which required decontamination.

** Same carrier.

*** Same carrier on route 028 to Montgomery, AL.

Appendix C-3

Vehicle Monitoring Results

Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
10/18/79	GA Tech	2-160	Atlanta to Barnwell, SC	0.06	0.8	0.13	LSA	none	cask secured to trailer	yes	yes	cask USA 6144/B
10/25/79	Note 1	15207	014	0.0	16	unk	16.6	unk	rear	yes	yes	
		15181	028	0.0	19	unk	15.5	unk	rear	yes	yes	
		15170	305	0.0	5	unk	2.2	unk	right rear	yes	yes	
		16152	(a)	0.2	15	0.9	3.5	unk	right rear	yes	unk	Note 2
10/27/79		P83094	AC	0.5	95	15	252.5	Se-75, Mo-99, I-131	rear	yes	yes	inbound Atlanta
		P83094	AC	0.5	95	13	198.3		rear	yes	yes	outbound Atlanta
		XRC92U	SK					unk	full		yes	Note 3
10/28/79		55	NE	0.03	12	1.0	104.9	Se-75, Mo-99, I-131	front	yes	yes	
		15209	015	0.5	18	1.8	27.5	unk	rear	yes	yes	
		15164	005	0.1	3.6	0.4	2.0	unk	left rear	yes	no	Note 4
		16721	400	0.8	10	unk	14.3	unk	rear	yes	yes	
		15219	080	1.6	unk	unk	22.2	unk	middle rear	yes	yes	
		15145	008	0.3	15	1.5	14.2	unk	rear	yes	yes	
		15214	028	0.3	60	5	94.2	unk	rear	yes	yes	
		15189	101	1.4	10	1.4	20.2	unk	rear	yes	yes	
11/27/79	Note 5	544	Note 5	0.11	9	1.1	LSA	none	cask	yes	yes	
	GA Tech	881	Atlanta to Barnwell, SC	0.03	1.3	0.1	LSA	none	trailer full	yes	yes	Note 6
12/1/79		XRC92U	SK	3.0	70	unk	unk	none	full	Note 7	no	Note 7
		XRC92U	SK	0.8	50	3.5	unk	none	rear	yes	yes	Note 8
		P83094	AC	0.5 0.9 (sleeper)	100	18	196.3	Se-75, Mo-99, I-131	rear	yes	yes	Note 9

Appendix C-3 (cont'd)

Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
12/2/79		15212	080	1.2	33	1.5	21.6	unk	left rear	yes	yes	Note 10
		15214	028	0.7	100	6	95.9	unk	rear	yes	yes	
		16724	400	1.4	30	4	43.4	unk	rear	yes	yes	
		15223	015	0.4	48	1.3	34.4	unk	rear	yes	yes	
12/13/79		16144	028	0.07	65	unk	18.1	unk	right rear	yes	yes	Note 11
		15227	305	0.04	10	unk	2.2	unk	left rear	yes	no	
		15207	015	0.04	25	unk	17.8	unk	rear	yes	no	
12/16/79		NEN55	NE	0.2	18	1.4	110.1	none	front	yes	yes	
		15212	080	1.4	10	unk	17.2	unk	rear	yes	yes	
		15223	015	0.1	unk	unk	33.4	unk	rear	yes	yes	
		15224	028	0.8	60	unk	98.1	unk	rear	yes	yes	
		16719	400	2.0	35	2.3	45.3	unk	middle	yes	yes	Note 12
		15145	008	1.4	18	1.0	15.5	unk	left rear	yes	yes	
		15190	100	1.0	10	1.0	20.9	unk	rear	yes	yes	
2/24/80		NEN55	NE	0.3 0.8 (sleeper)	16	2.2	153	none	front	yes	yes	
		15202	103	0.4	5	unk	3.5	unk	rear	yes	yes	
		15217	080	1.2	12	1.4	33.1	unk	rear	yes	yes	
		16724	400	0.7	12	1.2	38.9	none	rear	yes	yes	
		15188	012	0.2	3	0.2	2.5	unk	left rear	yes	yes	
		15214	028	0.4	30	3.7	38.2	none	rear	yes	yes	
		15223	015	0.1	28	1.4	31.4	none	rear	yes	yes	
3/20/80		15231	028	0.03	0.2	0.06	0.3	unk	rear	yes	NA	
3/21/80		15207	014	0.02	0.02	0.02	0.1	unk	middle	yes	NA	
		15231	028	0.04	0.6	0.03	0.9	unk	middle	no	NA	Note 13
3/23/80		15223	028	0.3	27	1.2	29.2	unk	rear	yes	yes	
		16724	400	0.1	28	1.2	24.8	unk	left rear	yes	yes	Note 14
		15214	15	0.2	20	1.5	26	unk	rear	yes	yes	
		15210	101/103	0.9	14	1.6	24	unk	rear	yes	yes	
		15205	008	0.9	10	0.6	11.4	unk	left rear	yes	yes	

Appendix C-3 (cont'd)

Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
3/25/80	Eastern Cargo	15149	035	0.4	10	unk	5.2	unk	rear	yes	yes	Note 11
		15207	014	0.3	10	0.2	2.6	unk	right rear	yes	yes	
		15227	108	0.03	0.2	unk	0.5	unk	rear	yes	NA	
3/29/80		P83094	AC	0.8 1.0 (sleeper)	74	9.8	146.3	Se-75, Mo-99, I-131	middle	yes	yes	Note 15
		XRC92U	SK	2.5	80	8.8	unk	none	full	-	yes	Note 16
		XRC92U	SK	1.5	58	5.8	unk	none	full	-	yes	Notes 16, 17
3/30/80		NEN55	NE	0.1 0.2 (sleeper)	12	1.5	116.3	Se-75, Mo-99, I-131	front	yes	yes	
4/26/80		P83094	AC	0.4 0.9 (sleeper)	70	10	185.6	Se-75, Mo-99, I-131	rear	yes	yes	
		XRC92U	SK	0.3 0.8 (passenger)	30	unk	unk	none	rear	-	yes	Notes 16, 18
	East Pt., GA	TEA529	SK1	3.2 3.5 (passenger) 11.0 (rear)	80	7	143.0	unk	rear	-	yes	Notes 16, 18
4/27/80		NEN55	NE	1.8 (Note 19)	18.5	unk	35.4	none on steering wheel, rear bed, unk	front	yes	yes	Note 18
		15213	080	0.8	14	1.7	29.1	unk	middle rear	yes	yes	Notes 11, 20
		15223	028	0.6	55	4.5	43	unk	rear	yes	yes	
		16724	400	0.4	30	3	47.9	unk	rear	yes	yes	
		16738	100	0.8	14	unk	27.1	unk	rear	yes	yes	
		15180	015	0.7	35	2.5	32.2	unk	rear	yes	yes	
		15205	008	0.8	18	1.9	14.5	unk	rear	yes	yes	
5/17/80		P83094	AC	0.4 0.6 (sleeper)	80	12	227.1	none	rear	yes	yes	Note 21
6/19/80	Eastern Cargo	15149	035	0.3	unk	unk	2.6	unk	front and rear	yes	yes	

Appendix C-3 (cont'd)

Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
6/21/80		P83094	AC	0.2	35	7	215.1	Se-75, Mo-99, I-131	rear	yes	yes	Notes 18, 22
	Hapeville, GA	XTM792	SK	1.2	54	unk	272.6	Co-57	front to middle	-	yes	Notes 16, 18
	Hapeville, GA	TEA529	SK1	3.5	70	5.2	135.5	unk	rear	-	yes	Notes 16, 18
		WJ1484	SK2	0.9	26	1.3	16.0	none	rear	yes	yes	
6/22/80	NEN, Atlanta	NEN55	NE	0.2	15	2.1	192.3	Se-75, Mo-99 I-131	middle	yes	yes	
				0.4 (sleeper)								
		15201	080	0.4	10	1.2	13.4	unk	rear	yes	yes	
		15234	001	0.2	3.2	0.3	2.5	unk	rear	yes	yes	
		15205	008	0.3	15	1.3	11.0	unk	rear	yes	yes	
		15235	015	0.4	15	1.5	31.6	unk	rear	yes	yes	
		16724	400	0.6	20	1.7	45.6	unk	middle rear	yes	yes	Note 23
		15168	100	1.1	20	2	27.3	unk	rear	yes	yes	
		15214	028	0.9	16	unk	43.3	unk	rear	yes	yes	
6/23/80		15207	015	0.02	0.05	0.03	0.1	unk	rear	yes	yes	
		15225	089	0.02	0.2	0.03	0.2	unk	front	unk	yes	
		37064	(b)	0.02	2.6	0.05	0.4	unk	rear	no	yes	Note 24
6/29/80	Charlie Brown Airport, Atlanta	NEN55	NE	0.12	12	2	261.8	Se-75, Mo-99, I-131	middle	yes	yes	Note 18
				0.2 (sleeper)								
7/30/80		15207	014	0.02	0.2	0.04	0.1	unk	right rear	yes	NA	
8/9/80		P83094	AC	0.2	45	9	249.1	Se-75, Mo-99, I-131	rear	yes	yes	
	East Pt., GA	XRC92U	SK	2.5	90	unk	unk	none	full	unk	no	Note 25
				10 (sleeper)								
	East Pt., GA	XRC92U	SK	0.4	unk	unk	unk	none	rear	unk	no	Note 26
				0.8 (sleeper)								
	East Pt., GA	TEA 529	SK1&2	3.8	70	7	143.6	none	rear	yes	yes	
				5 (passenger)								

Appendix C-3 (cont'd)

Date	Location	Vehicle	Route	Radiation levels (mR/hr) Cab	Surface	Six ft.	Transport Index	Removable Contamination	Package Placement	Proper Shipping Documents	Placards	Remarks
8/12/80	Eastern Cargo, Atlanta, GA	15235	035	0.6	28	unk	13.7	unk	rear	yes	yes	
9/17/80	Emery Air Freight East Pt., GA	125351-2	EM	0.6	5	0.8	2.4	unk	front	yes	NA	
9/18/80		15227	108	0.05	0.7	0.2	0.8	unk	right rear	yes	yes	
		15207	014	0.04	0.1	0.08	0.4	unk	rear	yes	no	Note 27
		15231	028	0.03	unk	unk	0.7	unk	rear	yes	yes	Note 28
9/20/80		P83094	AC	0.19 0.3 (sleeper)	30	9	243.6	Se-75, Mo-99, I-131	rear	yes	yes	
	East Pt., GA	XRC92U	SK	2.2 3.0 (sleeper)	45	4	unk	none	full	unk	yes	Note 16
	East Pt., GA	TEA 529	SK1	5.2	40	unk	unk	none	full	yes	yes	Note 29
9/21/80	Charlie Brown Airport, Atlanta	NEN55	NE	0.4 1.1 (sleeper)	11	3	300	none	front	yes	yes	
		16724	400	0.6	25	2.4	46.8	unk	rear	yes	yes	
		15233	028	0.6	32	unk	41.9	unk	rear	yes	yes	
		15252	015	0.1	20	2.2	30.6	unk	rear	yes	yes	

Notes:
1. All locations at Terminal D, Atlanta, Georgia unless otherwise noted.
2. Vehicle monitored while parked outside terminal building; driver had not arrived from Birmingham yet. Unknown if placards were displayed when vehicle actually departed.
3. Driver did not grant permission to monitor vehicle. After off-loading RAM for Atlanta, GA, the driver and assistant repositioned RAM destined for Orlando, FL towards rear of vehicle. Prior to departing terminal, driver gave permission to

place a TLD behind driver's seat and driver accepted new personnel TLD. The driver said that his current TLD was in his other van. TI of 101.1 was off-loaded at Atlanta, GA per freight bills.

4. Vehicle was noted departing terminal without displaying placards. Subsequently, vehicle returned and driver mentioned that he displays the placards in the morning when he departs on his route.
5. LSA shipment (7.46 Ci) in cask 6722/A from Browns Ferry enroute to Barnwell, SC was monitored at rest area at I-20 near Conyers exit. Subject shipment had been used for an exercise in which GA officials participated with TVA authorities, who called a simulated radioactive shipment accident.
6. Consolidated shipment was LSA from Emory University, Morehouse College and Georgia Institute of Technology. Upon arrival at Barnwell, SC it was reported that the 2-ton contaminated shield leg punctured the base of the container and slightly contaminated the trailer, which required decontamination.
7. Total TI was unknown; however, per freight bills for RAM off-loaded at Atlanta, GA, TI was 104.9. Driver does not have a compilation of RAM TI by destination. TI is only shown on individual freight bills. Driver's log does reflect number of pieces and weights by destination for road scale checks. Only left side of vehicle had placard displayed. Some RAM packages fell out when rear door was opened.
8. Vehicle was remonitored outside terminal after driver repositioned RAM destined for Orlando, FL towards rear of vehicle. Reading in sleeper was 4.2 mR/hr. TI was unknown. This driver is always cooperative. Driver wore company dosimeter on his belt.
9. RAM packages were stacked very high and some appeared to have fallen from top of stack toward rear of trailer. Previously, Mo-99 generators were stacked only four generators high.
10. Reading in cab was 3.3 mR/hr until driver and trainee moved RAM towards rear of vehicle.
11. Driver was reminded to display placards.
12. Only four foot separation distance between driver and RAM
13. Terminal I manifest provided to terminal D driver only listed "Med Test Kits" for two RAM with yellow II labels and TI of 0.1 each.
14. Driver took only SQ RAM and all freight bills, therefore next driver could not have any shipping papers for remaining RAM at TI of 33.2. Terminal D operates two vehicles on same route to keep TI on vehicle below TI of 50.

15. SK driver loaded SQ RAM destined for Orlando, FL on AC trailer. Cab reading did not increase with additional RAM.
16. Driver is not provided a consolidated bill that lists isotopes, activity, and TI for each destination; driver is only provided with individual freight bills.
17. Readings were taken after Florida and Georgia RAM were off-loaded: TI of 69.9 off-loaded for Georgia and 19.8 for Tennessee per freight bills.
18. Company is now operating under exemption DOT E 8308.
19. Readings included contribution from RAM inside building.
20. Initial reading in cab was 3.0 mR/hr with only 3½ feet separation. Driver was reminded that more separation distance was required.
21. Vehicle was also inspected by representative from DOT Federal Highway Administration.
22. Trailer has 5,000 lbs of steel plating on front and sides to reduce radiation readings.
23. Driver loaded RAM with only 3 feet separation distance with a cab reading of 1.9 mR/hr. Driver was reminded that more separation distance was required.
24. Ga-67 package shipping papers did not include type label or TI.
25. One RAM package fell out when door was opened. One placard was missing.
26. Vehicle remonitored after off-loading some RAM.
27. Front placard was covered by air deflector; however, no III label RAM was on vehicle.
28. TI and shipping documents did not reflect RAM package that had a TI of 0.6.
29. Only 4 feet separation distance. A vehicle survey as required by exemption DOT E 8308 was not performed.

Appendix C-4

Noncompliance in Radioactive Waste Shipments to the Barnwell, SC Site through Georgia, Reported by US NRC Inspectors, October 1979 - September 1980

Date, 1980	Shipper	Violation
March 18	Hatch Nuclear Power Plant	2.6-3.7 mrem/hr in cab of truck
April 25	Browns Ferry Nuclear Power Plant	600 mrem/hr at surface of trailer
July 31	Hatch Nuclear Power Plant	"Radioactive" placard missing from front of truck or trailer

Appendix C-5

Surface Contamination Measured by Smears
of Vehicles and RAM Packages

Date	Area, cm^2	Object smeared	Radionuclide level, pCi/100 cm^2 Se-75	Mo-99	I-131	Other
1979						
27 October	5,600	AC trailer, rear of bed	0.7	0.1	<0.1	--
28	3,000	NE trailer, rear of bed	<0.02	<0.02	<0.02	(Co-57) 0.05
1 December	1,900	AC trailer, rear of bed	0.54	<0.2	0.21	--
	520	AC assistant driver, bottom of shoes	1.0	0.24	0.34	--
1980						
24 February	13,600	Mo-99, 10 boxes, NE	<0.01	0.04	<0.02	--
19 March	100	ionization source boxes	--	--	--	(Co-60) 1.7
21	25,000	5 SQ I-131 (2) Cr-51 (1) Co-57 (2)	0.02	<0.02	<0.02	--
23	2,800	Mo-99, 2 packages, NE	<0.1	0.24	<0.1	--
29	2,100	AC trailer bed	0.15	<0.1	<0.1	--
30	1,390	NE trailer bed	<0.1	1.5	<0.1	--
26 April	2,800	AC trailer bed	0.13	0.10	<0.1	--
21 June	5,600	SK vehicles-rear bed and steering wheel	<0.05	<0.05	<0.05	(Co-57) 0.07
21	7,000	AC vehicle-rear bed and steering wheel	<0.08	0.05	<0.08	--
22	7,000	NE vehicle-rear bed and steering wheel	<0.03	0.05	<0.03	--
29	1,850	NE vehicle-rear bed	<0.3	<0.3	<0.3	(Co-57) 0.3
30 July	13,000	I-131 overpack, MA	0.2	<0.05	<0.05	--
9 August	5,000	Mo-99, 3 packages, MA	0.4	<0.2	<0.2	--
9	1,600	AC, rear bed	1.2	<0.2	<0.2	--
12	100	Mo-99 pkg at airport, MA	<5	7.8	<5	--
12	100	Inside Mo-99 package at airport, MA	<10	250	<10	--
12	1,200	Airport apron, gloves, etc.	<0.1	2.8	<0.1	--
12	100	Inside package at airport, MA	<10	580	<10	--
12	2,900	Mo-99 package (repackaged after airport incident), MA	<0.1	0.14	<0.1	--
12	1,600	Mo-99 package at airport	0.3	0.12	<0.1	--
19	1,800	Mo-99 overpack, SQ	<0.1	<0.1	<0.1	(Co-60) 0.2
20 September	1,600	AC, rear bed	0.9	<0.2	<0.2	--

Appendix D-1

Terminal D Personnel Radiation
Monitoring with TLDs

TLD #	Position (route)	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
1	Office Secretary; Control	14	17	12	57
3	Driver (028)	30 (21)+	24	17	79
4	Driver (028) (Sunday)	65	42	30	180
6	Driver (014)	36	20	14	92
7	Weekend Dispatcher/supervisor	54	28	14	120
10	Driver (086)	NR*	70 (67)	14 (12)	55
11	Driver (037 & 086)	14 (4)	30	21	110
12	Driver and Terminal Sorter	52	81	101	310
14	Supervisor	19	17	12	63
15	Terminal Sorter	NR	--	--	--
18B	Driver (002)	22	17	16	72
19A	Driver (305)	17	16	11	58
36A	Driver/Supervisor	19	16	22**	75
39	Driver (035)	30 (21)	19	18	75
43	Driver (008)	NR		36 (41)	--
45	Driver (100)	NR	80 (27)	18	130
46	Driver (400)	76	NR	96 (26)	220
47A	Driver (045)	21	18	14	70
48	Driver (001)	14	15	12	54
49	Driver (016 & 004)	23	22	14	78
53	Driver (103)	NR	50 (27)	13	150
56	Sorter, weekends	NR	220 (42)	19	230
60	Driver (100 & 108)	NR	NR	81 (71)	59

Appendix D-1 (cont'd)

TLD #	Position (route)	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
75	Driver (400)	NR	NR	21	--
76	Driver (005)	22	18	13	70
77	Driver (006)	20	19	13	69
83	Supervisor, weekend	28	NR	27	107
84	Sorter, week nights	22	17	11	66
89	Driver (001)	21	18	16	72
90	Driver (080)	NR	NR	NR	--
93	Driver (015)	NR	NR	63 (40)	--
95	Driver (022)	NR	NR	45 (40)	--
96	Driver (080)	34	NR	40 (26)	96
99	Driver (008)	NR	NR	40 (41)	--
100	Sorter, weekend	53 (4)	NR	NR	--
102	Driver (101 & 103)	--	--	37 (26)	--
103	Driver (008)	--	NR	NR	--
105	Driver (008)	--	7 (8)	20	--
106	Driver (103)	--	--	71	--

* NR - not recovered.
\+ Number of weeks other than shown in heading.
** TLD issued October 25, 1979 and recovered on September 17, 1980 had a reading of 61 mR.

Appendix D-2

Terminal C Personnel Radiation
Monitoring with TLDs

TLD #	Shift	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
1	(B)	Clerk (office on 2nd floor) (Control)	25 (21)**	21	14	67
3	(C)	†CSA Add-to/Spec Ser and Inbound	14	NR	29 (26)	56
4	(C)	Gate Agent, Main Terminal	NR*	NR	NR	--
5	(C)	Unload'g Aircraft, Main Term.	NR	NR	NR	--
6	(A)	†SCSA	56 (58)	--	--	--
6A	(A)	SCSA Spec Ser Agent	14	14	12	52
7	(C)	CSA Add-to	16	15	10	53
8	(A)	CSA Sorter	15	15	10	52
9	(C)	Ticket Counter, Main Terminal	25 (21)	NR	NR	--
9A	(C)	SCSA Spec Ser Agent	16	15	10	54
10	(D)	SCSA Floor	16	17	11	58
11	(D)	SCSA Spec Ser Agent	20	17	14	67
12A	(D)	SCSA Add-to/outbound	NR	NR	NR	--
13	(D)	SCSA Sorting Area	NR	25 (27)	13	50
16	(C)	Spec Ser Agent	16	18	16	66
17	(C)	Spec Ser Agent	17	16	NR	64
18	(D)	SCSA	NR	25 (27)	10	46
19	(D)	SCSA	18	15	15	63
20	(E)	Gate Agent, Main Terminal	NR	NR	NR	--
21	(C)	Senior Ser Agent	NR	30 (27)	17	61

Shift: (A) 2315-0700 (B) 0800-1700 (C) 1500-2330 (D) 0700-1515

* NR - not recovered.

** Number of weeks other than shown in heading.

† CSA/SCSA - Customer Service Agent/Senior Customer Service Agent

Appendix D-3

Terminal G Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
1	Ramp Service (1620-0020)+	16	16	13	59
2	Ramp Service (1620-0020)	14	NR*	23 (26)**	48
3	Ramp Service (0010-0810)	17	12	10	51
4	Supervisor (0800-1700)	21	17	14	69
5	R/S Front door and belt man (1620-0020)	22	20	13	72
6	Lead Ramp Service (0010-0810)	15	NR	NR	--
7	Ramp Ser Air Express (0900-1730)	19	10	NR	56
8	Ramp Ser Air Express (0110-0910)	28 (21)	14	12	60
9	Ramp Service (1620-0020)	--	--	17	--

* NR - not recovered.
** Number of weeks other than shown in heading.
\+ Working hours.

Appendix D-4

Terminal A Personnel Radiation Monitoring with TLDs

		Exposure rate, mR/period			
TLD #	Position	12/13/79 to 3/20/80	3/20/80 to 6/23/80	6/23/80 to 9/17/80	Annual Average
1 A	Night Ramp Agent	19	NR*	NR	----

*NR - not recovered.

Appendix D-5

Terminal I Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/14/79 to 3/20/80	3/20/80 to 6/20/80	6/20/80 to 9/17/80	Annual Average
1	Driver, Atlanta area	20	15	14	65
2	Driver, Atlanta area	18	14	12	58

Appendix D-6

Carrier SK Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/15/79 to 3/22/80	3/22/80 to 6/21/80	6/21/80 to 8/9/80	8/9/80 to 9/20/80	Annual Average
50	Driver	NR*	2,300+	380**	310++	3,500
59	Driver	1,300	NR	NR	NR	4,800

Notes: 1. Route - New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA; to Orlando, FL. Effective March 29, 1980, Orlando, FL route was dropped. Route now terminates in TN.

* NR - not recovered.

\+ Exposed for 34 weeks. In addition, another TLD (#50) issued July 28, 1979 was recovered on June 21, 1980 and had a reading of 1044 mR. However, TLD was not on person but in a box beside driver's seat.

** TLD was sent to Atlanta in RAM vehicle on August 2 and carried in another RAM vehicle enroute to Alabama before TLD was recovered. Reading does not entirely reflect driver's exposure and is not included in the annual average.

++ TLD was reissued to driver, who placed TLD in his wallet; however, alternate driver found TLD in vehicle compartment at time of recovery. Therefore, reading does not entirely reflect driver's exposure and is not included in the annual average.

Appendix D-7

Contractor for Carrier SK (Atlanta, Georgia): Personnel
Radiation Monitoring with TLDs

TLD #	Position (route)	Exposure rate, mR/period 4/26/80 to 4/28/80	5/2/80 to 6/20/80	6/20/80 to 9/20/80	Annual Average
1a	Driver (wallet)	29	120	140	660
1b	Driver (shirt pocket)	24	-	-	-
2	Driver	-	NR*	130	-
3	Driver	30	120	240	930
4	Driver	48	NR	43 (13)**	-

Notes:

1. Route - East Point, to Columbus, GA and intermediate stops at hospitals enroute to Montgomery and Birmingham, AL. On April 26, 1980, three drivers were in vehicle to learn route. Drivers are supposed to alternate for weekend runs.

   Driver #1 also transports RAM to hospitals in Atlanta area on Saturday evenings.

2. TLD #2 was issued to driver on May 2 and recovered on August 5, had a reading of 50 mR.

* Not recovered.

** Number of weeks other than shown in heading.

Appendix D-8

Carrier AC Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/13/79 to 3/29/80	3/29/80 to 6/21/80	6/21/80 to 9/20/80	Annual Average
52	Driver	650 (21)+	NR*	930 (26)	1,750
73	Driver	900 (22)	NR	850 (28)**	1,830
104	Driver	---	NR	650 (26)	1,300
1	Driver	---	--	460 (16)**	1,500
2	Driver	---	--	420 (16)**	1,360

Notes: 1. Route - St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC, to West Palm Beach, FL.

2. Drivers sometimes switch to a Texas route from St. Louis, MO.

* Not recovered.

\+ Number of weeks other than shown in heading.

** Until 10/14/80.

Appendix D-9

Carrier NE Personnel Radiation
Monitoring with TLDs

TLD #	Position	Exposure rate, mR/period 12/16/79 to 3/30/80	3/30/80 to 6/22/80	6/22/80 to 9/28/80	Annual Average
1	Driver	1,100 (22)*	NR+	580 (26)	1,930
4	Driver	850 (22)	NR	690 (26)	1,680
5	Driver	NR	NR	1,060 (40)	1,380
6	Driver	NR	NR	1,040 (41)	1,320
7	Driver	--	--	230	860
8	Driver	--	--	270	1,000

Notes: 1. Route - Billerica, MA; Atlanta, GA; Nashville, TN; Oak Ridge, TN; to Billerica, MA. In June 1980, route includes Orlando, FL.

2. Drivers alternate on weekend trips.

\+ Not recovered.

* Number of weeks other than shown in heading.

Appendix E-1

Vehicle Radiation Monitoring with TLDs

TLD #	Vehicle #	Route ID	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
Terminal D (Ground Forwarder)						
20	15180	(015)	NR*	NR	NR	---
22	15181	(028)	22	20	NR	81
23	15170	(039)	24	NR	12	70
24	15171	(015)	NR	NR	NR	---
25	15147	(a)	NR	NR	NR	---
26	15201	(086, 039)	30	Lost	16	89
27	15207	(014)	16	18	12	60
28	15194	(305)	39 (25)**	NR	29 (26)	70
29A	15182	(086)	36 (21)	18	13	75
30	16144	(028)	NR	NR	NR	---
32	56078	(b)	NR	NR	NR	---
33	37064	(018)	NR	18	11	58
34	15165	(024, 037, 080, 039)	NR	NR	NR	---
35A	15174	(081)	22	20	16	76
38	16111	(a)	NR	NR	NR	---
40	15149	(035)	34	28	31	120
44	15145	(008)	NR	NR	72 (40)	---
54	15203	(080)	30	29	24	109
57	15208	(100)	NR	NR	NR	---
61	16725	(400)	NR	NR	NR	---
62	15205	(008)	85 (38)	40	25	120
64	15178	(011)	NR	NR	94 (46)	---
65	912	(039)	22	18	10	65
66	15209	(081)	45	NR	43 (26)	120
69	15186	(051)	19	NR	27 (26)	60
72	15192	(081)	21	19	14	71
81	15218	(100)	NR	NR	NR	---
85	15214	(028)	80	29	30	180
86	16724	(400)	580 (26)	200	94	870

Appendix E-1 (cont'd)

TLD #	Vehicle #	Route ID	Exposure rate, mR/period 12/13/79 to 3/20/80	3/20/80 to 6/19/80	6/19/80 to 9/17/80	Annual Average
91	15289	(080)	NR	NR	77 (40)	---
92	15227	(305)	14	13	8.9	47
94	15223	(015)	47	NR	49 (26)	120
97	15212	(080)	43	NR	74 (26)	150
98	15224	(028)	29	23	14	86
101	15231	(028)	--	NR	9.8	---
AC						
87	P83094	(c)	580 (21)	330	210	1,240
NE						
3	55	(d)	410	112	113	830
SK						
88	XRC92U (driver's seat)	(e)	1,400	2,100 (f)	430 (6)	5,100
	(passenger's seat)				670 (6)	---

Notes:
(a) Atlanta to Birmingham, AL.
(b) Atlanta to SC.
(c) St. Louis, MO; Memphis, TN; Birmingham, AL; Atlanta, GA; Charlotte, NC to West Palm Beach, FL.
(d) Billerica, MA: Atlanta, GA; Nashville and Oak Ridge, TN.
(e) New Brunswick, NJ; Richmond, VA; Charlotte, NC; Atlanta, GA to Orlando, FL.
(f) TLD was issued on March 29 and was recovered on August 9; however, local contractor driver carried TLD in his vehicle with RAM on August 2-3.
* Not recovered.
** Number of weeks other than shown in heading.

Appendix E-2

Vehicle Radiation Monitoring with TLDs - Contractor
for SK (Atlanta, GA)

TLD #	Vehicle # *	Exposure rate, mR/period 4/26/80 to 4/28/80	5/2/80 to 6/20/80	6/20/80 to 8/9/80	8/9/80 to 9/20/80	Annual Average
5	TEA 529 (behind driver's seat)	36	360	100 (1)	300	1,300
6	TEA 529 (behind passenger's seat)	--	510	NR	410	4,900
7	TEA 529 (behind rear seat)	250	1,560	(2)	1,980 (2)	9,900

Notes: 1. It was reported that TLD was inadvertently sent to NJ. Upon return, TLD was carried in vehicle compartment.

2. TLD reading was for 2 periods.

* East Point, Georgia to Columbus, Georgia with intermediate stops at hospitals to Montgomery and Birmingham, Alabama. Vehicle departs every Saturday night after transferring RAM from SK vehicle which started at East Brunswick, NJ.

Appendix F

Site Radiation Monitoring with TLDs

TLD Location		Exposure rate, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80	2/13/80 to 5/15/80	5/15/80 to 8/12/80	8/12/80 to 9/10/80	Cumulative Annual Average (No. of Quarters)
Terminal K							
1C*	Office, under desk	--	15	17	16	6.6	64 (3)
2	RAM Area, south wall	--	33	39	28	11	133 (3)
Terminal F (a)							
1C	Office, on wall	M+	34	30	--	--	130 (5)
2C	Breakroom, on wall	M	M	27	--	--	150 (4)
3	Left side RAM area, on wall	51	39	44	--	--	170 (4)
4	Center RAM area, on wall	M	M	40	--	--	320 (4)
5	Right side RAM area, on wall	M	46	24	--	--	270 (5)
6	Pillar south/east side outbound area	24	20	20	--	--	85 (3)
7	Wall, south side outbound area	45	43	38	--	--	170 (3)
8	Pillar, west end outbound area	M	16	21	--	--	74 (2)
9	Pillar, west end outbound area	M	18	26	--	--	88 (2)
Terminal C							
1C	North wall	32	29	32	24	10	140 (10)
2C	East wall	31	30	30	32	10	120 (10)
3	Inbound RAM (Hazardous Holding area)	46	38	47	43	15	360 (10)
4	Outbound RAM	19	M	21	16	7	94 (8)
5	East wall between doors 6 & 7	26	31	23	22	8	100 (4)
6	Pillar, east side opposite doors 6 & 7	32	27	25	22	8	110 (4)
7	Office by radiac meters	--	--	--	--	109 (50)**	110 (4)

Appendix F (cont'd)

TLD Location		Exposure rate, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80	2/13/80 to 5/15/80	5/15/80 to 8/12/80	8/12/80 to 9/10/80	Cumulative Annual Average (No. of Quarters)
Terminal G							
1	RAM area, terminating bins 3 & 4	66	41	89	73	8	300 (6)
2	RAM area, terminating bins 1 & 2	54	52	71	28	12	250 (6)
3C	Steel pillar, SE end of terminal	16	15	16	12	6	61 (9)
4	RAM area, outbound	22	26	14	12	6	88 (9)
5	RAM area, inbound on steel pillar	15	14	15	15	12	200 (10)
6	RAM area, terminating bins 2 & 3	53	41	71	170	10	290 (10)
7	RAM area, terminating bins 4 & 5	52	31	45	38	7	310 (8)
8	Left side of pickup door #1	30	22	30	70	7	190 (6)
Terminal E							
1C	Office, under desk	M	16	15	15	6.2	65 (8)
2	RAM area, on post	32	14	30	760 (b)	29	120 (9)
Terminal A							
1C	Office	M	22	23	24	9	100 (10)
2	End of roller conveyor, east terminal	23	21	30	22	7	300 (11)
3	Bin pkg holding area outside ofc		20	M	25	9	90 (2)
Terminal H							
1C	Office	22	22	23	21	8	93 (7)
2	Wall, left corner RAM area	36	98	60	17	6	210 (4)
3	On pillar center of RAM area	34	88	260	M	6	510 (3)
4	New RAM area, on guard rail, NE side of building		--	--	40	35	--
5	New RAM area, on pillar, NE side of building		--	--	34	33	--
6	New RAM area, on post near overhead door, east side of bldg		--	--	42	140	--
7	New RAM area, on pillar, NE side of building		--	--	37	17	--

Appendix F (cont'd)

TLD Location		Exposure rate, mR 8/15/79 to 11/14/79	11/14/79 to 2/13/80	2/13/80 to 5/15/80	5/15/80 to 8/12/80	8/12/80 to 9/10/80	Cumulative Annual Average (No. of Quarters)
Terminal I							
1C	Office	M	17	M	19	6	77 (4)
2	RAM area, east wall	19	18	17	21	10	75 (4)
3	RAM area, post to left of east wall	20	20	20	16	6.8	75 (5)
Terminal D							
1C	Breakroom on water fountain	M	15	16	15	4.7	120 (10)
2	West wall, between doors 2 & 3	34	54	80	47	12	300 (6)
3	By dispatcher's window, inside cabinets	320	290	180	120	74	840 (10)
4	North wall, left side men's latrine	72	68	340	200	20	1,160 (11)
5	South wall, between doors 4 & 5	270	200	280	270	40	2,600 (11)
6	South wall, between doors 7 & 8	M	450	530	630	57	2,140 (10)
7	North wall, by door 16	92	62	69	65	18	2,100 (8)
8	South wall, between doors 1 & 2	57	35	52	163	88	340 (7)
9	East side between doors A & B	690	560	1,000	660 (c)	230	2,530 (6)
10	East side between doors B & C	560	440	760	460	200	1,890 (6)

Notes: a. Terminal F, in Atlanta, Georgia ceased operations effective May 15, 1980.

b. Annual average does not include this value. On June 20, 1980, TLD 2 was missing; but it was recovered on August 12, 1980. The high reading was discussed with supervisor but could not be resolved. A replacement TLD #2 installed on June 20, 1980 and recovered on August 19, 1980 had a reading of 76 mR.

c. On July 30, 1980, a driver returned TLD #9 which he found in his vehicle. TLD was also held in terminal office until recovered; therefore, reading is questionable.

* C denotes Control TLD.

\+ M: Missing.

** Number of weeks of exposure in parentheses.

Appendix G

Exposure Rates from Mo-99 Generator Packages
as Function of Inverse Square of Distance

No. of packages	Configuration	Exposure rate, mR/hr per TI, as function of distance^{-2}, ft^{-2} 2.0	0.073	0.022	0.0106	0.0062	0.0041	0.0029
Squibb, 2.1 ± 0.1 TI each, 12"x12"x12"								
1		24	0.95	0.26	0.124	0.076	0.052	--
3	side by side	11.6	0.85	0.27	0.124	0.073	0.048	--
4		8.6	0.94	0.27	0.131	0.068	0.045	--
5		8.0	0.84	0.25	0.124	0.072	0.045	--
6		5.8	0.76	0.26	0.119	0.073	0.048	--
7		6.0	--	0.23	--	0.074	0.045	0.032
8		4.0	0.68	0.24	0.119	0.071	0.045	0.033
2	1 x 2 high	11.0	0.79	0.26	0.109	0.067	0.045	--
4	2 x 2 high	6.0	0.89	0.25	0.131	0.067	0.044	--
6	3 x 2 high	6.0	0.76	0.25	0.119	0.069	0.048	--
	mean:		0.82	0.25	0.122	0.071	0.047	0.032
	std. dev.:		0.09	0.01	0.007	0.003	0.003	0.001
New England Nuclear, 2.1 ± 0.1 TI each, 14.5"x14.5"x15" high								
		1.56	0.069	0.022	0.0104	0.0061	0.0040	0.0028
1		20.5	0.86	0.26	0.119	0.071	0.048	--
3	side by side	9.5	0.87	0.30	0.159	0.097	0.076	0.056
5		6.0	0.76	0.27	0.133	0.083	0.059	0.042
6	3 x 2 high	5.8	0.75	0.28	0.143	0.087	0.058	0.039
8	4 x 2 high	4.6	0.80	0.28	0.125	0.071	0.045	0.030
10	5 x 2 high	4.2	0.67	0.26	0.171	0.076	0.048	0.034
9	3 x 3 high	7.0	0.90	0.25	0.122	0.069	0.046	0.031
	mean:		0.78	0.27	0.139	0.080	0.054	0.039
	std. dev.:		0.07	0.02	0.020	0.010	0.011	0.010
Mallinckrodt, 0.9 TI, 16"x16"x17" high								
		1.31	0.066	0.021	0.0102	0.0060		
1		18	0.89	0.28	0.122	0.078		

Note: Distance includes one-half of package width plus 2" detector radius; actual distance to center of nearest source is greater than indicated for even number of packages.

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This report describes the third year study, covering the period October 1979 through September 1980, conducted by the State of Georgia and the Georgia Institute of Technology, under NRC/DOT contract, to monitor radioactive material transport through Georgia. During the three years of the study, 12,000 radioactive material packages per year moved through the State, with 97% of the packages containing radiopharmaceuticals. Fuel cycle and low-level waste material accounted for 1,200 surface vehicle trips per year, while medical/industrial/research radioactive material accounted for 2,100 trips per year. Vehicle and package inspections uncovered infrequent violations, none of which posed serious threats to worker or public health and safety. Of 148 transport workers deemed most likely to be exposed to radiation, personnel monitoring with thermoluminescent dosimeters (TLD's) showed only half received doses above background levels. The majority of workers in the highest dose category (above 500 mR/yr) were drivers of interstate vehicles carrying only radioactive material. Practices for reducing these radiation exposures are discussed in the report.

The results of the first- and second-year studies are contained in NUREG/CR-0931 and -2033, respectively.

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